TOPICS OF THE MONTH

International technical aid makes progress

IN the midst of wars, rumours of wars, and the seeming incompetence of politicians to deal with the complex problems of an uneasy world, the expansion of technical and economic assistance to the more backward countries, through the United Nations, shines out as the one bright spot in an otherwise gloomy landscape, and as one of the few practical contributions to world peace that have so far been made. No one with a knowledge of what such assistance means, particularly to those countries of the East whose goodwill is most sought after by politicians of the West, can doubt that if more money could be made available for this cause, *e.g.* by allocating to it some of the vast sums now being spent on armaments, the ultimate effect on international relations would be lasting and beneficial.

As one example of the practical results that have been achieved, a recent United Nations' report* points to a penicillin plant in Yugoslavia which, after experiments made with the help of an international expert, has been able to reduce the cost of its fermentation process by 6% and at the same time to increase its output by more than 30%. The advice of another expert has enabled the Government of that country to make use of some 100,000 locally manufactured blood plasma containers which had been considered unusable, and to institute a satisfactory process for the further manufacture of containers to meet the growing demand.

In Jordan, the advice of international experts has worked wonders with the potash industry. Production of potash has increased tremendously and with the implementation of present plans may well achieve an output of about a million tons in the next few years.

In such fields as this the efforts of the international experts, so long as they are not abused by the people they are aimed at serving, and so long as they are not prolonged beyond a reasonable limit of time in any one project, can do nothing but good.

New line of attack on chemical problems

THE announcement that Britain's Chemical Research Laboratory is to change its functions, in line with the recent proposals of the Council for Scientific and Industrial Research, so as to make a real impact on selected problems of national importance, will be welcome news to chemical engineers whose interests are now likely to receive much more consideration than hitherto. The Laboratory has lately concentrated more and more on research of industrial importance and application, as is shown by the summary of its latest work given elsewhere in this issue, but its efforts are still spread over a wide range of chemical problems. But now things are to change and, under its new name of the National Chemical Laboratory, the Laboratory will confine itself to a few objectives, covering only a limited part of the whole field of chemical research.

This means that the Laboratory will tackle problems which are appropriate neither to industrial research laboratories nor to universities, because of the necessity for special facilities, experienced staff and continuity of effort. Included in this category is the determination of the fundamental physico-chemical properties of chemical compounds which are required, for example, by chemical engineers for the design of full-scale industrial plant. The related study of the development of techniques of purification of materials such as metals and chemicals, with a view to the supply of standard samples of pure substances for reference purposes, is also marked down for attention.

The development of the atomic energy programme raises further urgent problems and the Laboratory is likely to give considerable attention to the problems of extracting elements of atomic energy interest from low-grade ores.

A third field to which the Laboratory aims to give increased attention includes the corrosion of metals, which has been estimated to cost the country about £600 million a year. The many industries affected are now much more aware of the need to take drastic measures with corrosion, due in no small part to the campaigning of our associate journal *Corrosion Technology* and to the Corrosion Convention and Exhibition which it organises, and the intention of the National Chemical Laboratory to engage in further fundamental and applied studies of this problem is to be welcomed.

Organising chemical projects

CHEMICAL projects are so complicated, and so diverse in the processes they employ and the products they produce, that it would be difficult to lay down any universal plan of approach to the job of planning and constructing them. But this does not give an excuse for an unscientific approach to the organisation of such projects. While some chemical and petroleum companies have a well-ordered system for tackling new projects, in others there is too much evidence of haphazard planning, with very often a single individual or small group of individuals, priding themselves on their practical, down-to-earth policy, getting things done by trial-and-error methods, bulldozing their way along and generally wasting a great deal of the time of other departments as well as their own.

* Supplement No. 5, Economic and Social Council Official Records, 26th Session. H.M.S.O., 1958.

Undoubtedly the happiest situation is where there is a well-integrated team of engineers whose individual functions and responsibilities are clearly defined and who are able to nurse the project through its various stages in accordance with a well-conceived plan. There is need for the mechanics of such a system to be more widely known and the symposium on 'The Organisation of Chemical Engineering Projects,' held at the time of the Chemical and Petroleum Engineering Exhibition in London, under the auspices of the Institution of Chemical Engineers and the Institute of Petroleum, was to be welcomed for this reason. The interest in this subject is indicated by the well-packed meetings, which attracted some 600 registrations. The symposium served a useful purpose in bringing together the best ideas of both manufacturing industry and chemical engineering contractors.

The paper by Sir Leonard Owen and Mr. C. J. Turner (United Kingdom Atomic Energy Authority) dealt essentially with the provision of new major chemical plants in which it is necessary to start from first principles. In the scheme of organisation for engineering services which was outlined in this paper the project engineer emerges as the key figure with a very big load of responsibility. As another contributor to the symposium pointed out, the term 'project engineering' is used in differing senses according to the organisation concerned; this speaker, Mr. K. M. Curwen (Albright & Wilson) defined it as the detailed design—both chemical and mechanical—drawing-office work, construction and commissioning of plant.

Several of the papers looked at chemical engineering projects from the contractor's point of view and gave a useful picture of the arrangements under which the contractor works. It was also useful to be able to compare the programming and progressing system favoured by a large chemical manufacturing concern (Shell Chemical Co.), as outlined by Mr. J. O. Dugdale-Bradley, with the system found expedient by a large contractor (Power-Gas Corporation Ltd.) and explained by Mr. W. V. M. Kelly. A description of the commissioning of a petroleum refinery and a coke-oven plant respectively, in the contributions of Mr. D. W. K. Barker (British Petroleum Co.) and Mr. A. F. Cottrell (Woodall-Duckham Construction Co. Ltd.) made a further interesting comparison.

The two papers by Mr. S. T. Card (Distillers Co. Ltd.) and Mr. R. Adams (George Wimpey & Co.) deserve study by those who are in doubt about the analysis of project records and their use on later occasions. One use of such records is, of course, in cost estimating and, as Mr. P. Brett (I.C.I. Ltd.) pointed out in his paper on cost estimating and control, the surest way of knowing how much a plant will cost is to have full details of how much a similar plant did cost. For a quick estimate, allowance can then be made for increase in the cost of labour and materials and for changes in circumstances. As well as this quick estimate Mr. Brett outlined the method of arriving at closer estimates and also dealt with cost control.

New match factory has striking features

PLANT unique in Britain, and probably in Europe, to take delivery of hot, molten paraffin wax and keep it molten will be a feature of Bryant & May's new £300,000 Glasgow match factory, now structurally completed, which will produce over 4 million matches an hour. Where, hitherto, paraffin wax has arrived in metal drums for melting and heating, at the Glasgow factory it will be delivered in the hot, molten form in insulated road tankers and pumped into a heated underground storage tank, whence it will be delivered to the dipping tanks on the match machines. This process is economical, and ensures a uniform supply of clean wax.

Other new features include the latest ideas in fire precautions, and equipment for evaporating half a ton of water daily for drying off match heads. To assist this drying process, air is drawn into the building by fans and, when necessary, heated by hot-water units. Both the flow of air and its temperature can be accurately controlled. The moist, warm air leaves the building through Colt roof ventilators.

Match sticks, or 'splints,' will arrive at the factory already impregnated with ammonium phosphate and dried. The next stage of dipping in hot paraffin wax ensures a steady flame after the ignition of the head. Finally the match stick is dipped into composition, which provides the striking head. Each match machine will be equipped with a portable, high-pressure carbon dioxide cylinder to deal with the tiny fires which are normally a daily occurrence. Each machine will also have six water hoses supplied from the mains and, in addition, extinguishers of both the water and powder type are available in areas where there are special risks. Hoses connected to the hydrant system are available at strategic points and, finally, the whole building is covered by an automatic sprinkling system.

Towards the perfect road tanker

THE use by Bryant & May of bulk road tankers for carrying their hot paraffin wax is just another example of the trend, previously remarked upon in these columns, towards using this form of transport, wherever possible, for all sorts of liquids. The petroleum and chemical industries are prominent amongst users of bulk road tankers and have had a good deal of influence in the development of tanker design. Those firms which are not in the fortunate position of being able to operate their own tanker fleets can turn to the professional road hauliers, who are to be complimented on the surprising amount of knowledge they have gained in handling liquid cargoes of all kinds. Their versatility is apparent when it is considered that, when a customer wants to move tung oil, pyridine, di-chlorethylene, or cyclo-hexane, the haulier must know at once what type of tank is suitable, what are the special properties of the liquid, its specific gravity, its tolerance of heat and cold and, finally, after much else, what it will cost to transport it direct to the place where it is wanted.

This and other aspects of the haulier's business were discussed by Mr. J. G. Arnold, of Pickfords, in a recent road transport survey in the *Manchester Guardian*. He reminds us that, in addition to liquids, there are developments today in the tank haulage of certain free-flowing powders, such as carbon black. Mild-steel tanks are used for molasses, bitumen, fuel oils, crude vegetable oils and concentrated sulphuric acid. Dilute sulphuric calls for a rubber-lined tank, as do hydrochloric and hydrofluoric acid. Aircraft fuels, and some food products, require (for the sake of an ultimate standard of cleanliness) stainless-steel or *Epikote*-lined tanks. For other traffic, aluminium tanks are most suitable.

The hauliers continue the search for the ' universal ' tanker—one which will be suitable to carry glue, acid, wine or any other liquid or near-liquid. This would materially reduce the presently unavoidable running of empty mileage, thus materially reducing costs. So far, the stainless-steel tank is the nearest approach to such an ideal, but it is very costly and there are commodities for which even stainless steel is unsuitable.

The ' ideal ' tanker, when found, will doubtless be found economical by chemical companies also, especially where a variety of liquids are handled and it would be advantageous to switch tankers from one to another.

Small firms need a big hand with technical problems

A TREMENDOUS gap between small and medium-sized firms and potential sources of information is indicated by a recent survey carried out in Scotland. In recent years there have been similar enquiries in Manchester, Birmingham and the North-east into how firms get their information and how they try to solve their technical and commercial problems, and the findings of this latest survey seem to confirm the need for technical information centres to help such firms. The survey, carried out by an experimental Technical Liaison Service run by the Scottish Council, reveals a danger that, as firms get their information mainly from a limited number of suppliers and other firms, they will rely on a closed circuit of experience and will not become aware of new developments which could be of use to them.

Literature was mentioned almost three times as often as any other source as a means of keeping in touch with developments. Its value depended on the number and quality of the publications received and the care with which they were read by staff. The team's reports suggest that, although one person in each firm usually studied journals, arrangements for circulation, abstracting and filing varied considerably.

Not all the problems encountered were due to lack of knowledge; thus the shortage of steel of certain types prevented some firms from undertaking new developments or even, occasionally, from accepting all the orders they received. One firm manufacturing chemical machinery had to contract out work in stainless steel while its own factory was underloaded, because of the inadequate supply of this material.

It appears significant that, out of ten firms which fully planned their innovations, eight employed technically qualified staff, nine had research or design departments themselves or in their parent company, two belonged to research associations and eight to trade associations.

As a result of this enquiry it has been recommended that a permanent technical liaison service should be provided in Scotland; at first it would help small and medium-sized firms, but later it should be extended to other industries. However it was felt that the operation of regional schemes like this belongs properly to the Department of Scientific and Industrial Research and that an official network of regional services might be provided.

An account of the survey and its findings is given in a booklet, ' Small Firms With Big Problems,' which is available free from the D.S.I.R. Lending Library Unit, 20 Chester Terrace, Regents Park, London, N.W.1.

Winding up on Windscale

IT was hardly to be expected that any startling conclusions would emerge from the deliberations of the committee, headed by Sir Alexander Fleck, which was set up to enquire into the Windscale atomic pile accident last October, or that any drastic changes would be advocated as regards the design and operation of such piles. If the committee's conclusions prove anything, it is that an atomic pile is an extremely complicated and delicate piece of equipment which, because of the special hazards involved, requires much more concentrated effort in its engineering and operation than it has hitherto been the custom to give in any other industrial operation, however hazardous.

The main part of the committee's report* is concerned with the problem of Wigner energy in graphite and with recommending a procedure for the release of Wigner energy in Windscale's No. 2 pile. A substantial increase in the number of instruments is advocated, especially thermocouples, and the committee also makes recommendations for improving the filters which are installed to trap any possible emission of radioactive material from the chimneys at Windscale (this despite the fact that the modification will entail some capital expenditure and will involve a greater pressure drop across the filters and a consequent reduction in output).

The existing design of fuel cartridge was found to be satisfactory, but not so the lithium/magnesium cartridge, which, the committee says, needs modification.

A new method of releasing Wigner energy was used on the B.E.P.O. reactor at the Atomic Energy Research Establishment, Harwell, in March this year and was considered as a possible alternative to the method previously used at Windscale. However, a full examination of this question would be a long procedure and the committee of enquiry thought it most unlikely that, even if this method were eventually shown to be

* Cmnd. 471, H.M.S.O., 1s.

safe, it could be applied within a period of 12 months. But the committee thinks that an effective procedure could be arrived at by combining the B.E.P.O.-type release with the 'slow heating' method, the aim of which is to release the Wigner energy gradually by slowly raising the temperature of the graphite to about 200°C. by a flow of heated air. In the combined method, the graphite temperature would first be raised slowly to 120°C. by heating the ingoing air, and would be maintained at that temperature for about 12 hr.; the pile would then be cooled down to room temperature again. This preliminary heating would remove some of the Wigner energy and reduce the maximum graphite temperature that might be reached in a subsequent self-sustaining release by about 80°C.; the maximum graphite temperature would then be within acceptable limits. Second, the graphite temperature would be raised rapidly to about 160°C., again by heating the ingoing air. This would bring about the release of the remaining low-temperature stored energy.

This method would certainly be effective, since all the graphite could be heated by hot air, and it would not be necessary to rely on transfer of heat from block to block to spread the release. Since the period of heating in the second stage would be considerably shorter than would be required for the slow heating method, the problems of stresses in the concrete structure would be less severe. The provision and installation of the necessary equipment for heating the air would require six to nine months and the pile could be operational within about a year.

Since the winding up of the committee of enquiry, the Atomic Energy Authority have decided that it would not be economic to rehabilitate Windscale's No. 1 pile. Some of the buildings will be adapted to other uses and the remainder sealed off.

Computer checks chemical structures

ATTEMPTS are being made to use automatic computers to help relieve patent examiners of the drudgery of patent searches. The work is being done by the U.S. Patent Office and the National Bureau of Standards. The task of the patent examiner, of course, is to find whether a claim put forward relates to anything that has been previously patented. This may require a search of anything up to 10 million documents.

The first computer trials have been attempts to search for chemical structures. Over 200 descriptions of steroid compounds were exhaustively searched by a high-speed electronic computer to answer typical questions that might occur in evaluating a patent application. The system used required the numbering of each atom in a structural diagram serially in arbitrary order. One unit of computer storage, called a word, was given to each atom to represent its position in the structure. In each word were listed the numbers of the other atoms, up to four, that were attached to the atom represented by the word. The element symbol and the serial number of the atom were also placed in the word. Thus each coded atom word was given six fields: the serial number of the atom, four connection fields, and an element symbol.

The search programme tried to make an atom-to-atom match between the atoms of the question structure (the structure in the patent application) and the atoms of the first structure recorded in the file. If the machine found that all possible first matches led to irreconcilable mismatches, it rejected the first file structure and proceeded to the next. When a one-to-one correspondence existed between each of the atoms of the question structure and the atoms of part of the file structure that was being examined, the computer printed an indication of the structure that had been found. This process continued until the whole file was examined.

Now that a start has been made it is certain that refinements and improvements will be made steadily, as operators get used to the computer system. If and when computers can be used for routine patent searches the whole process of granting or rejecting claims will be greatly accelerated.

Oxide recovery cuts acetylene production costs

ONCE or twice lately we have commented on developments in the manufacture of acetylene from natural gas, particularly in the United States; lest it be thought that American acetylene producers who use calcium carbide as their starting point are ready to throw up the sponge we must take a look at the latest idea of the National Carbide Co., one of America's biggest manufacturers of acetylene by the more conventional route. This shows itself in a process for reclaiming calcium oxide for re-use in the manufacture of carbide, and so *ad infinitum*—a sure winner where cost savings are concerned. National Carbide think so, or they would not be building a $2-million calcium oxide recovery plant at Calvert City, Kentucky, and planning a similar one at their Louisville carbide/acetylene plant, also in Kentucky.

Briefly, the new reclamation process consists of taking the wet calcium hydroxide that is left over when acetylene is generated from calcium carbide, partially dewatering it by means of a centrifuge, and feeding it into a rotary kiln where both the free and combined water are driven from the line at elevated temperatures. The calcium oxide which is left in the kiln is then briquetted—and this is the tricky part—using high-pressure briquette presses, and is ready for re-use in calcium carbide furnaces.

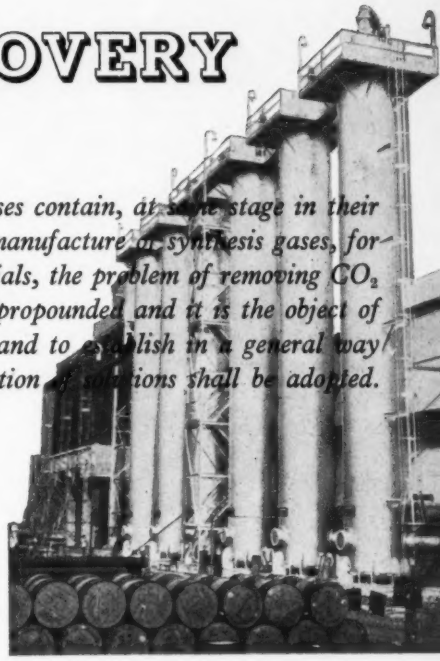
When completed, each of the company's new calcium oxide recovery plants will be capable of producing some 250 to 300 tons/day of the reclaimed material. It is anticipated that each plant will employ about 20 men.

While National Carbide are not the only acetylene producers to have thought of, and tried, reclamation of the oxide, they certainly seem to have hit on a very practicable way of doing it and this development deserves to be watched closely, not only by other American producers, but wherever calcium carbide is used as the raw material.

CO_2 REMOVAL AND RECOVERY

Many of the gases which enter into our modern industrial processes contain, at some stage in their production, carbon dioxide as an unwanted constituent. In the manufacture of synthesis gases, for example, whether derived from solid, liquid or gaseous raw materials, the problem of removing CO_2 inevitably arises. Numerous solutions to the problem have been propounded and it is the object of this short review to consider some of the better known processes and to establish in a general way the particular conditions that determine which solution or combination of solutions shall be adopted.

By T. W. Sharp
(*Chemical Plant Division, Power-Gas Corporation Ltd.*)



Six carbon dioxide water scrubbers, for CO_2 removal at the Sindri fertiliser factory, built by Power-Gas for the Government of India.

IT is hardly possible to isolate the problem of CO_2 removal and consider it independently of subsequent steps in the purification and use of the major gas stream. CO conversion, CO_2 removal, CO removal and, when present, H_2S removal, all hang together and determine to some extent what form the CO_2 process shall take. In turn, these intermediate stages reflect such variables as the type of raw feed and method of gasification, the pressures and temperatures available or required at various points, and local conditions of steam, water, effluent disposal, etc.

Most of the methods for removing CO_2 are based upon its acid character when in solution and employ various alkaline reagents to effect the removal by combining with the CO_2 to form a salt. In order that the neutralising agent shall be capable of more or less indefinite recirculation, the salt should be of an unstable character, easily dissociated by the application of heat and/or by the release of pressure. The other main characteristic which is made use of in removing CO_2 is its solubility in water.

Water washing

It would obviously be of advantage to use the cheapest solvent, water. Unfortunately, CO_2 is only slightly soluble in water under normal atmospheric conditions. In consequence, the water-washing process has to be operated under pressure. The required high vapour tension of CO_2 over water is plainly a virtue when desorbing, as by releasing the pressure the bulk of the CO_2 escapes from solution. This action can be observed when a bottle of lemonade or soda water is opened. Indeed, one of the chief uses of carbon dioxide when it is to be recovered from industrial gases is in the soft drinks industry. Increasing quantities of CO_2 are also being consumed in the manufacture of urea and in the gypsum process of ammonium sulphate manufacture. Interesting and important innovations are the application of the gas to the binding and hardening of sand moulds and cores in foundry work and its employment in gas-cooled nuclear energy reactors of the Calder Hall type.

Table 1. Volumes of CO_2 at 0°C. and 760 min.Hg. Absorbed per Volume of Water at Varying Pressures and Temperatures

Pressure atm. (abs.)	0°C.	15°C.	20°C.	25°C.	30°C.
1	1.797	1.019	0.878	0.759	0.665
3	5.32	2.990	2.578	2.225	1.945
5	8.65	4.803	4.126	3.545	3.086
7	11.78	6.528	5.603	4.810	4.186
10	16.03	9.014	7.778	6.710	5.865

The solubility of CO_2 in water is a function of the temperature of the solution and the partial pressure of the CO_2 in contact with the water, decreasing with the temperature of the solution and increasing with the partial pressure of the CO_2. This is indicated quantitatively in Table 1. When dissolving a given quantity of CO_2 from a gas, whatever its CO_2 content, by washing the gas with water, the quantity of water required is decreased as the temperature of the water is decreased and the pressure of the gas is increased.

It is interesting at this stage to consider what effect the presence of H_2S has when deciding whether to adopt the water-washing process. H_2S is two to three times as soluble in water as CO_2, so that where other conditions indicate water washing, the presence of H_2S would not seem to be a hindrance. However, the stripping of

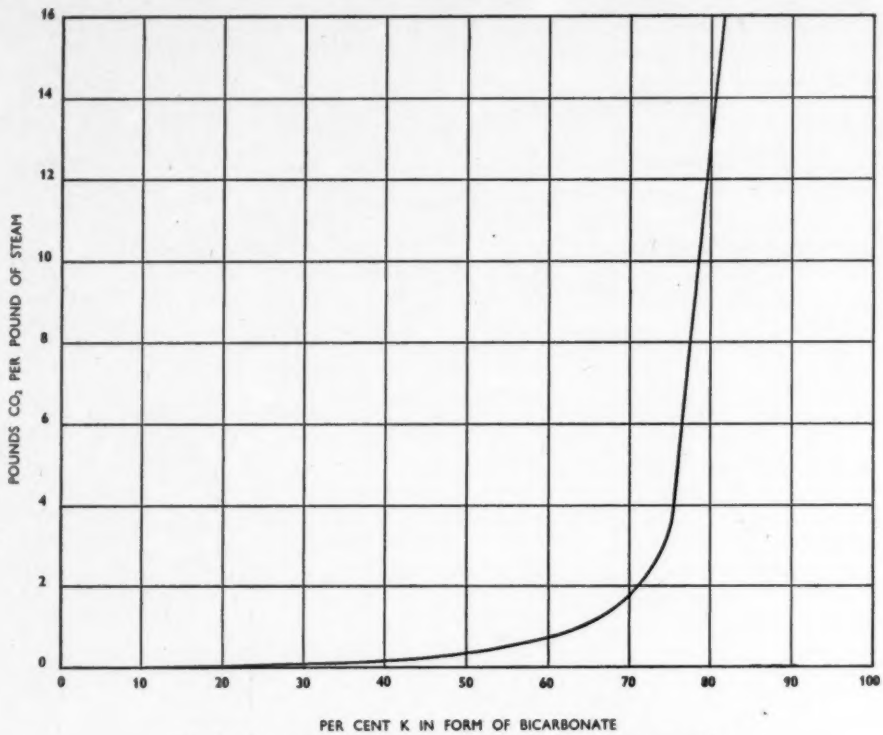


Fig. 1. Curve showing carbon dioxide in equilibrium with potassium bicarbonate solution at its boiling temperature.

the CO_2 from the water is normally completed in a tower of the water-cooling type against a current of air and the presence of even minute quantities of H_2S in the waste going to atmosphere may offend against regulations controlling noxious effluents. Waste gases from such towers have been passed to boiler furnaces so that the H_2S may be burnt to SO_2 with further dilution before exhaustion through a high chimney. An alternative is the use of oxide boxes before water washing to reduce the H_2S to permissible levels.

Two conditions have now been established which are material to detailed consideration of water washing: (1) the gas stream to be treated should be at pressure, and (2) the CO_2 content should be high. Both these considerations apply on a large scale in the fertiliser industry when ammonia is to be manufactured from synthesis gases.

A generation ago, synthetic ammonia was almost exclusively derived from solid fuels such as coke, starting with the water gas process. Water gas, a mixture of roughly 50% CO and 50% H_2, is made by alternately blowing air and steam through a bed of coke. The CO is catalytically converted to CO_2, and the latter removed by water washing. Nitrogen is added at some stage in the process and the correct mixture of hydrogen and nitrogen is converted over a catalyst at high pressure into ammonia. If the nitrogen is added as air during steaming of the coke in the generator, the result is a semi-water gas. Multi-stage compression raises the gas to the required synthesis pressure of about 300 atm. and the CO_2 is washed out at some intermediate stage, generally between 10 and 30 atm. Theoretically, a gas containing 50% hydrogen and 50% CO would yield, after conversion of the CO, a mixture with $33\frac{1}{3}$% CO_2. Allowing for the addition of nitrogen, the gas to the water-washing unit would contain up to 27% CO_2. Raised to 10 atm. pressure (11 absolute) CO_2 in these proportions would have a partial pressure of just under 3 atm. (abs.) and reference to Table 1 shows that at this pressure of CO_2 about $2\frac{1}{2}$ volumes at 0°C. and 760 min. Hg. of CO_2 are absorbed in 1 vol. of H_2O at 20°C. at saturation. In practice it is usual to base on a figure of around 70% saturation.

One of the disadvantages of this process is the loss by solution of other components of the gas stream, for example, hydrogen and nitrogen in ammonia synthesis. Both these gases follow Henry's law closely and though they are only sparingly soluble in water, their partial pressures in the gas stream are generally high. The hydrogen loss, which may be up to 4%, involves a fuel charge as well as the compression cost for both gases. The power consumption for pumping water to the required pressure is high, but about 40% of this may be recovered by installing an auxiliary drive on the pump in the form of a water turbine, through which the pressure of the water may be released in flashing off the CO_2. Fig. 4 shows a typical installation by the Power-Gas Corporation Ltd. of a synthesis gas plant with water absorption of CO_2. It is not usually considered economic to reduce the CO_2 content of the gas to less than 1% by this process, although when the inlet water tem-

perature is low enough it is possible to reduce the CO_2 content of the gas to about 0.2%. Subsequent CO removal by copper liquor washing also serves to bring down the CO_2 to low levels and a final caustic soda solution wash effectively cleans up.

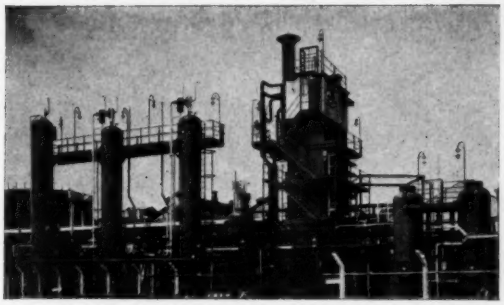


Fig. 2. A P.G.C.-Hercules reforming plant producing high-purity hydrogen from LPG and incorporating amine scrubbing of CO_2.

Alkali washing

For other than traces of CO_2 strong alkalis such as the hydroxides of sodium and potassium are too expensive in use, producing carbonates and bicarbonates which cannot be returned to the hydroxide by simple heating: an expensive and laborious process of liming is required:

$$2NaOH + CO_2 = Na_2CO_3 + H_2O$$
$$Na_2CO_3 + Ca(OH)_2 = 2NaOH + CaCO_3$$

The carbonates, soda ash and potash, have long been used for various purposes of CO_2 removal and the use of the latter has recently assumed considerable added importance with the advent of the so-called hot potassium carbonate process. Before going on to discuss this, however, it would be as well to follow the story through chronologically, especially with reference to the significance of the amine absorption process in the history of acid gas removal.

Ordinary solutions of sodium carbonate and potassium carbonate, although used extensively in the past for CO_2 removal and recovery, suffer from certain deficiencies. The primary purpose in employing an absorbent that reacts chemically with the solute to form a compound is to take advantage of the greatly enhanced solubility as compared with a purely physical absorption. For a particular pick-up of CO_2 it follows that the amount of absorbent in circulation is reduced, leading to smaller equipment sizes and decreased power consumption for pumping.

Carbonate removal of CO_2 is an equilibrium process of the type:

$$R_2CO_3 + CO_2 + H_2O \rightleftharpoons 2RHCO_3$$

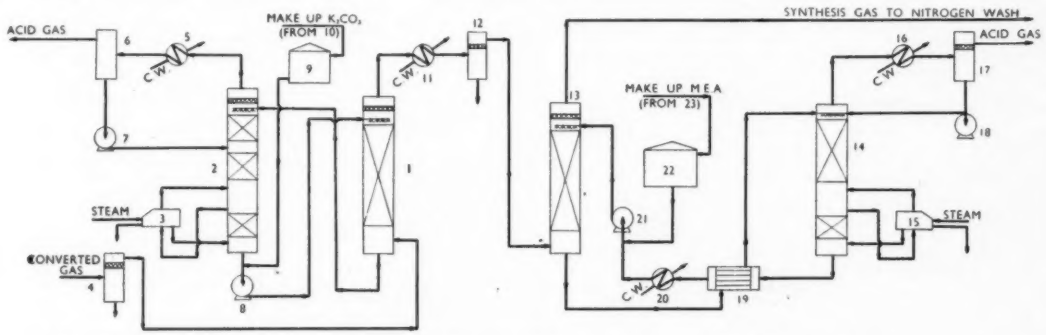
The reaction moves to the right or to the left in accordance with pressure, temperature and reactant concentrations. Low temperatures and high partial pressure of CO_2 favour the formation of the bicarbonate: high temperatures and low partial pressure of CO_2 the reverse. Naturally, it is desirable to push the reaction as far to the right as possible.

According to the law of mass action, K the equilibrium constant =

$$\frac{(RHCO_3)_2}{(R_2CO_3)\,(CO_2)}$$

If the concentration of carbonate in the reaction is increased, the concentration of bicarbonate increases in like proportions to maintain the equilibrium and CO_2 is taken up. Similarly, if the concentration (*i.e.* the partial pressure) of the CO_2 is increased, the reaction again moves to the right to maintain equilibrium. Desorption, on the other hand, calls for a reaction going as far to the left as practicable and this is sought by heating the rich solution to increase the volatility of the CO_2 and drive it out of the system. As soon as the concentration of CO_2 falls, more is evolved from the bicarbonate in order to maintain equilibrium. In practice, an end-point is reached when the consumption of steam (for heating) becomes excessive for each additional per cent. of bicarbonate returned to the normal salt.

Soda ash is the cheapest of the alkaline solvents, but its usefulness is circumscribed by the relative insolubility in water of the bicarbonate



1	Potassium carbonate absorber	9	Potassium carbonate storage tank	17	MEA reflux tank
2	Potassium carbonate regenerator	10	Pot. carb. make-up tank and pump	18	MEA reflux pumps
3	Regenerator reboiler	11	Synthesis gas cooler	19	MEA solution heat exchanger
4	Knock-out drum	12	Knock-out drum	20	MEA solution cooler
5	Acid gas cooler	13	MEA absorber	21	MEA solution pumps
6	Reflux tank	14	MEA reactivator	22	MEA storage tank
7	Potassium carbonate reflex pumps	15	MEA reboiler	23	MEA make-up tank and pump
8	Potassium carbonate solution pumps	16	Acid gas cooler		

Fig. 3. Flow diagram of combined hot potash/amine scrubbing system for a synthetic ammonia plant.

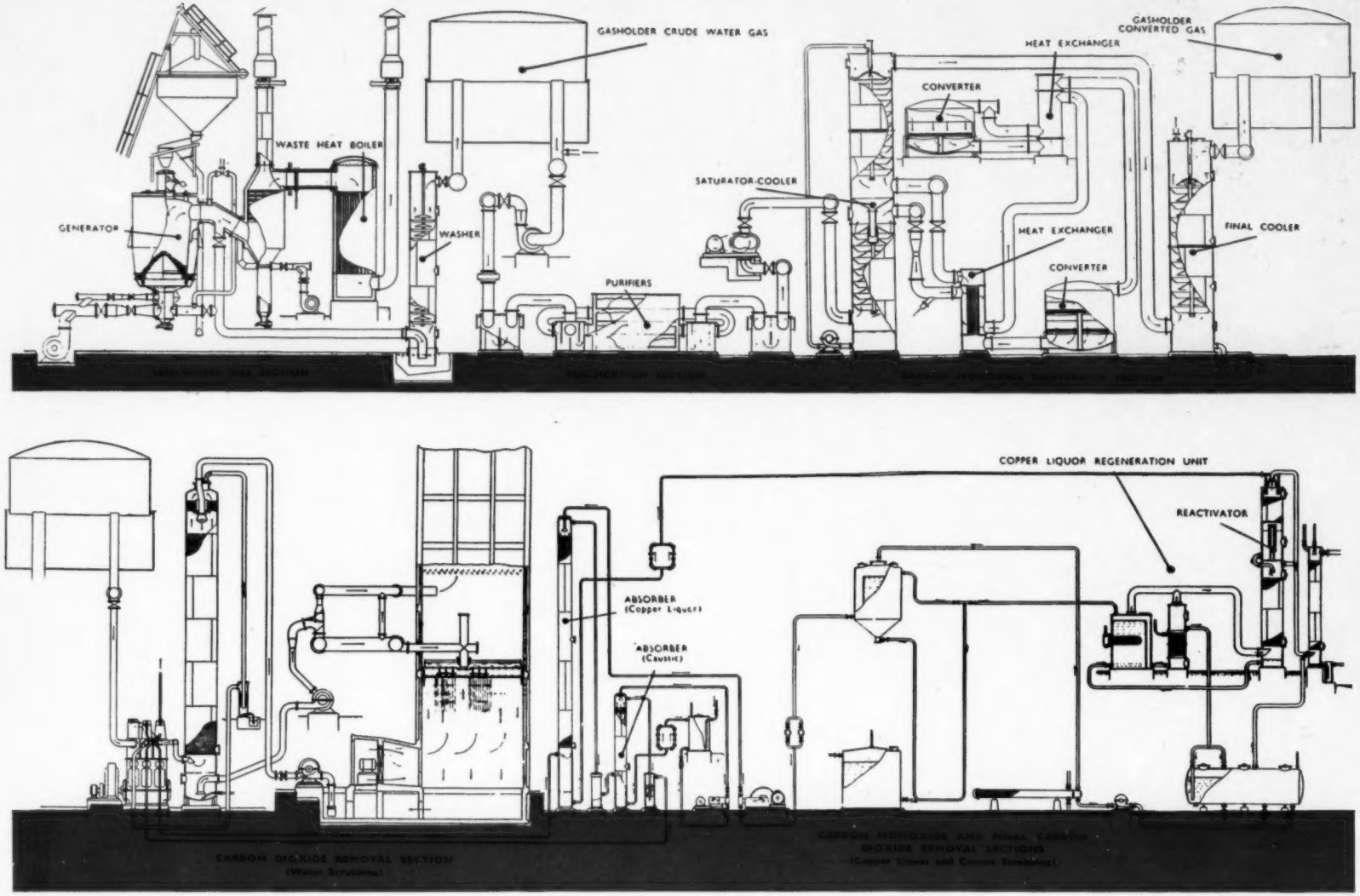


Fig. 4. Typical synthesis gas plant showing (*above*) low-pressure system and (*below*) high-pressure system.

(Table 2): potash suffers from the same defect although not to the same degree, but its cost is considerably higher.

In consequence of the solubility factor the strength of solution is limited, sodium to about 2.5N and potassium to about 4.5N. The quantity circulated for a specific pick-up of CO_2 is therefore high, leading to equipment costs greater than would otherwise be necessary. Steam consumptions with these systems are also high, weak solutions obviously demanding more heat in the reboiler merely to deal with the unavoidably high dilution content of water. A study of equilibrium data for both sodium and potassium carbonate/bicarbonate solutions shows that during reactivation the rate of steam usage increases very rapidly below a certain ratio of bicarbonate/carbonate concentration. Fig. 1 suggests that substantially complete stripping, which would ensure minimum solution flow rates, is hardly likely to be economic when balancing steam against capital costs. In commercial practice, at the concentration of bicarbonate (40%) in the lean solution going to the absorber, the partial pressure of CO_2 over the solution is such that when dealing with flue gases the CO_2 content must approach the order of 18% to make recovery attractive. For lower concentrations, especially below 14%, the absorption efficiency as reflected in the percentage of carbon dioxide absorbed falls way rapidly. At best, little more than one-half of the CO_2 present in flue gases is recovered, the remainder passing on to waste. The normal lye system is hardly competitive today with amine scrubbing, save in exceptional circumstances and there is no doubt that over the last two decades in new installations for removing acid gases, the *Girbotol* process has held a commanding position.

Amine washing

The ethanolamines are organic bases having formulas RNH_2, R_2NH, R_3N, where R stands for the group CH_2CH_2OH. Since their introduction on a commercial scale in the early 1930s, many hundreds of plants utilising aqueous solutions of the ethanolamines have been put to work to remove acid gases from natural and refinery gas streams, to purify synthesis gases of various compositions and to provide large quantities of pure CO_2 for the food and drink industries. Fig. 2 shows a power-gas installation removing CO_2 by amine scrubbing from a reformer gas in the production of pure hydrogen.

Table 2. Solubility of Sodium and Potassium Bicarbonates in Water (Grammes/100 Grammes, at Varying Temperatures)

	Temperature						
	0°C.	10°C.	20°C.	30°C.	40°C.	50°C.	60°C.
$NaHCO_3$ ..	6.9	8.15	9.6	11.1	12.7	14.45	16.4
$KHCO_3$ ..	22.05	27.7	33.2	39.0	45.3	49.9	60.0

Monoethanolamine (MEA) is the common absorbent for CO_2 removal; stepwise the reactions may be represented:

$$2RNH_2+CO_2+H_2O \rightleftharpoons (RNH_3)_2CO_3$$

$$(RNH_3)_2CO_3+CO_2+H_2O \rightleftharpoons 2RNH_3HCO_3$$

MEA has a large capacity for CO_2 and at the usual absorbent temperature (about 100°F.) the equilibrium pressure of Co_2 is negligible. Hence, by counter-current washing it is possible to strip the CO_2 from a gas stream down to very low limits. The process is partly one of physical absorption, partly of chemical combination, so that pressure considerations are not so important as in water washing where physical absorption is controlling. The solution flow rate is more nearly linear with respect to CO_2 content in the gas being washed and the advantage of pressure operation on solution capacity is limited.

The ethanolamines are miscible with water in all proportions and there is no limiting factor in this respect on the strength of solution possible, although other considerations make it advisable to limit MEA to a 20% by weight solution. At such a strength the temperature rise in the absorber is not so high as greatly to affect the equilibrium CO_2 pressure and hence the carrying capacity of the solution. The volatility of MEA being low, there is little vaporisation carry-over in the scrubbed gas leaving the absorber from these solutions. The loss by absorption from the gas stream of valuable components (*e.g.* H_2, CO) is negligible.

A rich solution of MEA cannot be regenerated satisfactorily by boiling at atmospheric pressure. The reactivator is therefore put under a pressure of about 35 to 40 p.s.i.g. when the temperature reaches 280°F., at which point the CO_2 is almost completely stripped. Under these conditions a nett CO_2 removal of over 7 cu. ft. per gallon of solution has been achieved.

The main operating cost in the amine process is for steam. The reaction between amine and CO_2 is an exothermic one and the heat of reaction in the absorber has to be replaced from an external source during passage of the rich solution through the reactivator. This accounts for a large part of the heat load. The balance of the steam added in the reboiler serves to make good the factor by which the recovery of heat in the exchangers falls short of 100%.

Hot potassium carbonate washing

Attempts to improve the economy of such processes as those under review are always being made and in the hot potassium carbonate system of CO_2 removal substantial savings in steam may be achieved. For one thing, the heat of reaction between potassium carbonate and CO_2 is less than half that for MEA : CO_2; for another, absorption and reactivation are carried out at substantially the same temperature so that no heat exchange is involved between the rich and lean solutions.

At the temperature (225°F.) at which potash is circulated, the bicarbonate is very much more soluble than in the older 'cold' process: consequently, more concentrated solutions can be used with reduced flow rates and equipment costs. It is obvious, too, that the elimination of heat exchangers and solution coolers means a substantial saving in capital costs. Using a 40% solution of potash, CO_2 is absorbed at pressures of 200 p.s.i.g. and over and desorption is effected with a reduction in pressure down to about 3 p.s.i.g.

Although, for those conditions in which its use is justified, the hot potash process shows steam savings over other systems, steam is still the major charge. Compared with amine scrubbing, the most favourable steam economy is achieved in those cases where the partial pressure of the CO_2 is high, that is where the inlet gas is at pressures of 200 p.s.i.g. and over and the CO_2 content is upwards of about 20%. Under such conditions the greatest efficiency is attained when the CO_2 in the purified gas is reduced to a minimum of around 2%. Reductions down to 0.2% are possible, but the steam consumption at these lower concentrations increases rapidly. New hot potash process developments hold

(*Concluded on page* 286)

PALL RINGS and Packed Towers

By R. Hammond, A.C.G.I., A.M.I.C.E.

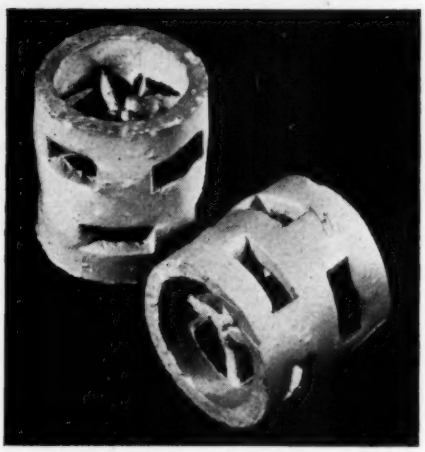


Fig. 1. Pall rings.

In an article in CHEMICAL & PROCESS ENGINEERING *last month, Prof. S. R. M. Ellis and Mr. J. Varjavandi reviewed developments in the field of tower packings and, in particular, discussed the latest results with various gauze packings. Another type of packing that has recently come into prominence is the pall ring, which is now being manufactured in Britain, and some experiments with this type of packing are discussed below.*

THE pall ring was evolved by the Badische Anilin und Soda-Fabrik (B.A.S.F.) of Germany, who recently appointed Henry Hawkins Ltd., Cannock, Staffs., as agents for the manufacture and sale of this type of ring in Great Britain. The essential feature of this ring is its perforated surface and the special arrangement of its inner segments. While retaining the main features of the Raschig ring in so far as the diameter is equal to the height, the pall facilitates a random packing distribution. Permeability is greater than that of a Raschig ring, owing to the openings provided in the cylinder wall, so that the resistance offered to the passage of gas by pall rings in random packing is exceptionally low. Moreover, the interior space of the ring is partially taken up by new surfaces.

In the case of the ceramic pall rings illustrated in Fig. 1, which are made in special machines at Longhouse Tileries, Cannock, where deposits of suitable clay are found, the contact surface exposed is up to 20% greater than that of a plain Raschig ring of comparable dimensions. The interior projections of the pall rings are so far from each end of the cylinder that they can never be reached by those of an adjacent ring of equal size; random distribution in a tower packing will, therefore, remain undisturbed. The weakening of material caused by the openings in a pall ring is largely counteracted by the mutual support provided by the interior projections, most of which meet in the axis of the cylinder.

The openings in the cylinder wall have been designed in such a manner that capillary liquid films, which might possibly close these openings, cannot form. The ends of the radial projections are either in direct contact with one another, or they are so close together that a smooth flow of liquid and gas is greatly increased as compared with all other forms of random tower packing.

Table 1 gives comparative packing data for stoneware pall rings, steel pall rings and stoneware Raschig rings.

Research on the loss of pressure through plain cylindrical rings of stoneware, compared with pall rings of the same diameter, has been undertaken by Dr.Ing. Alt, Ing. A. Meier and Dipl.Ing. C. Richter, of the technical research group of B.A.S.F.[1] Fig. 2 shows the apparatus employed, in which measurements were taken of loss of pressure and of entrained liquid through a random packing of stoneware pall rings 1 m. deep, and through a similar packing of sheet-iron pall

Table I. Comparative Packing Data

	Approx. dimensions (inches)	*Approx. weight (lb./cu.ft.)*	*No. of pieces per cu. ft.*	*Total surface (sq.ft./cu.ft.)*
	Random packings			
Stoneware pall rings	1 × 1 × 1/8	38	1,300	67
	1 1/2 × 1 1/2 × 5/32	34	520	50
	2 × 2 × 11/64	32	165	37
	4 × 4 × 11/32	28	21	17
	Stacked packing			
	4 × 4 × 11/32	39	30	25
	Random packings			
Steel pall rings	1/2 × 1/2 × 0.016	33	6,500	116
	1 × 1 × 0.024	30	1,470	72
	2 × 2 × 0.040	26	180	33
Stoneware Raschig rings	2 × 2 × 11/64	32	—	33.5
	4 × 4 × 11/32	28	—	13.5

rings 3 m. deep. The tower has an internal diameter of 600 mm., with an arrangement similar to a pipe condenser built into it about 300 mm. above the random packing, containing 85 brass nozzles through which the irrigating water was distributed over the whole area, the air driven upwards by the fan being led off through 22 short lengths of gas pipe expanded into each of the two end plates at the top of the tower. A pitot tube was fitted in the fan inlet pipe to measure air flow to the fan, and the entrained liquid was measured with the aid of the measuring tank.

Within the technically significant range of air velocity through an unirrigated random tower packing, the pressure drop with pall rings of 50 and 35 mm. diam. is 70 and 75%, respectively, of the loss incurred with plain rings of the same size. With an irrigated random packed tower, the results are even more favourable; for example, when the flow of irrigation water is 100 cu.m./sq.m. of cross-section of packed tower per hour, a tower packing of plain rings has capacity for only about 66% of the air which can pass through a pall ring packing. When the flow of irrigation water is increased to 200 cu.m./sq.m./hr., the throughput capacity for the plain rings is only 50% of the capacity through the pall rings.

Further experiments revealed that liquid entrainment by the upward current of air through the tower occurred at a velocity of from 1 to 0.5 m./sec. higher with pall rings than with plain rings. Measurements of the distribution of irrigation liquid across the packed tower proved that this factor was far more even with pall rings than with plain rings. Random dumped tower packings have a marked tendency towards throwing the irrigating liquid to the surrounding wall of the tower, thereby causing progressive reflux starvation at the centre; it is claimed that the pall ring reduces this effect, because it maintains a more uniform distribution.

Laboratory tests on the performance of pall rings were also carried out by Prof. Kirschbaum, of the Technical University of Karlsruhe, who compared the performance of the plain rings 50 mm. in diameter and 50 mm. long with that of similar random packing formed of pall rings of the same size.[2] In each case, the rings were packed in a column of 75 cm. supported by a metal grid. This column was tested as a fractionator for a 10% solution of alcohol and water in a batch still. The pall ring packing was proved to be more efficient and less sensitive to variation of vapour velocity; pressure drop was very much less than with plain rings, and entrainment was also much less.

Table 2. Liquid Entrainment Recorded in Experiments with Pall Rings and Plain Rings[2]

Vapour velocity (m./sec.)	*% liquid entrained*	
	Pall ring	*Plain ring*
1.0	0.12	0.15
2.0	0.25	0.32
2.5	0.34	0.41
3.0	0.44	0.76
3.25	0.50	4.10
4.0	2.40	Infinity

Table 2 shows typical comparative results of pall rings and plain rings as to the quantity of liquid entrained:

Experiments by other authors have proved that liquid distribution over a random packing of pall rings is much more even than over a corresponding packing of plain rings. Thus, in a random packed column of 40 cm. diam., maximum wetting occurred at the wall at a depth of 135 cm. when using plain rings; when using pall rings, however, maximum wetting was found to occur at 0.75 of the tower radius at the same depth.

Further tests have been undertaken by Dr.Ing. W. Pfannmüller[3] of the B.A.S.F. organisation, using air and water in an experimental packed tower, in order to investigate the relationship between resistance to gas flow in relation to both gas and liquid throughput. Air velocity was controlled by means of a variable-speed fan, giving an air velocity ranging from zero up to 3.5 m./sec., the rate of flow of the irrigating water having a maximum value of 13 cu.m./sq.m./hr. The results are shown by the accompanying curves (Fig. 3). With a liquid flow rate of about 12.5 cu.m./sq.m./hr., the pressure loss ratio of 44% was at an air velocity of about 2.2 m./sec.

Plain rings, Berl saddles and pall rings were compared during absorption and production of acetylene from a methane-oxygen split gas. The diameter of the experimental packed column was 20 cm., and the random packing was subdivided into four sections each 2.7 m. high. This system was subjected partly to a pressure of 8 atm. and partly to 1.3 atm.; in order to arrive at a criterion of efficient operation, the height equivalent to a theoretical plate was determined in each case, and the results are shown in Table 3. These values are averages from four to six tests and the deviation from the mean value is less than 5%. A superiority in performance of 40% over the plain rings and of 20% over the Berl saddles was observed.

Plain rings have also been compared with pall rings in a plant for producing sulphuric acid by the contact process, used for absorption and drying. The performance of the pall rings was greatly superior to that of plain rings, when the plant was loaded with 8.2 cu.m./sq.m./hr. of a 98% strength solution of sulphuric acid. With gas velocity of 43, 60 and 81 cm./sec., the pressure drop with plain rings was 48, 65 and 124 mm. water gauge, respectively, whereas the corresponding pressure losses with pall ring packings were 9, 12 and 24 mm. The vital point is that pall rings can operate at twice the normal gas velocity, yet offering only half the previous resistance. The economic significance of this hardly requires emphasis.

Advantages similar to those gained in absorption are also obtained with drying towers during manufacture of sulphuric acid by the contact process. Thus, in the above factory, the packed towers filled with 25-mm. plain rings caused a failure of the burner gas blower, due to entrainment of sulphuric acid; this involved a costly overhaul after a running period of only about five months. By changing over to pall rings, this condition did not arise in spite of a 30% increase of load. After a further running time of 18 months, inspection of the burner gas connections and conduit revealed that they were completely dry and clean.

In comparing bubble cap and sieve plates with tower packing, the greatest advantage of the latter is their lower

Table 3. Results of Tests with Three Types of Rings[3]

Packing body	*Material*	*Dimension*	*Height equivalent to a theoretical plate*
	Pressure, 8 atm.		
Plain ring	Metal	25 mm.	99 cm.
Pall ring	Metal	25 mm.	64 cm.
Berl saddle	Ceramic	35 mm.	107 cm.
Pall ring	Metal	35 mm.	84 cm.
	Pressure, 1.3 atm.		
Plain ring	Metal	35 mm.	131 cm.
Pall ring	Metal	35 mm.	80 cm.

pressure drop; when pall rings are used, this advantage is even more marked, perhaps the best example of this being in separation processes. In at least two cases, experience proved that distillation *in vacuo* of sensitive mixtures was possible only by using pall rings. In experiments with bubble caps, and also with alternative packing materials, owing to the greater resistance to flow through the packed tower, the still had to be heated to such an extent that the sensitive substances began to dissociate and underwent side reactions.

A vacuum distillation plant was operated at a throughput capacity of about 140 tons of paraffin-olefin mixture in the chain lengths of from 12 to 18 carbon atoms under a pressure of 60 mm. of mercury measured at the head of the column. At an average yield of about 75 cu.ft./hr. of distillate and an average reflux-flow ratio of about 15: 1, the vapour velocity in the column being about 6.8 ft./sec., the pressure drop had an average value of only about 145 mm. of mercury and the boiling range of the products of the vacuum distillation lay between 3 and 5°C.

A further example concerns the distillation of paraffin alcohol mixtures, in which pall rings were used with outstanding success. In this case the column had a diameter of 4.9 ft. and a total height of 37.4 ft. and contained 16 built-in grids of expanding metal. The alternative free spaces were filled with 2-in. pall rings to a height of 30.2 ft. In this case 484 cu. ft. of paraffin-alcohol mixture, in the chain lengths C17 paraffin and C18 alcohol, was charged and operated at a pressure of only between 2 and 3 mm. of mercury. The hourly yield was about 34 cu. ft. and the pressure drop reached the exceptionally low pressure of 20 mm. of mercury, the reflux-flow ratio being 4: 1.

To Authors

The Editor welcomes practical articles and notes on chemical engineering and related subjects with a view to publication. A preliminary synopsis outlining the subject should be sent to The Editor, CHEMICAL & PROCESS ENGINEERING, Leonard Hill House, Eden Street, London, N.W.1.

Cost

The question of cost is rather more complicated than it appears at first sight, for the manufacturers point out that, while pall rings are considerably more expensive than the equivalent in size of Raschig, a 2-in. pall can be subjected to the same duty as a 1-in. Raschig. Thus a tower filled with 2-in. pall will be approximately 10% cheaper than the same tower filled with 1-in. Raschig; but the story goes further than this again, as the tower can be reduced in size if filled with pall rings for the same throughput. The saving is therefore of the order of 40% owing to (1) 2-in. pall being cheaper than 1-in. Raschig and (2) the volume of tower packings required being less when pall rings are used, for a given throughput.

The manufacturers claim that, as a safe estimate, the following reductions can be made in a new tower design: cross-sectional area, 25%; height of tower, 20%; volume of packing, 40%. At the same time, the reduction in tower height and diameter decreases the costs of shell, packing supports, liquid distributors and other ancillary installations.

REFERENCES

[1] C. Alt, A. Meier and G. Richter, *Chem. Eng. Tech.*, 1955, **27**, 502.

[2] E. Kirschbaum, 'Report on the Examination of New Tower Packing Elements,' Department of Apparatus Design and Construction of the University of Karlsruhe.

[3] W. Pfannmüller, *Trans. Inst. Chem. Eng.*, 1954, **32**, Supplement No. 1.

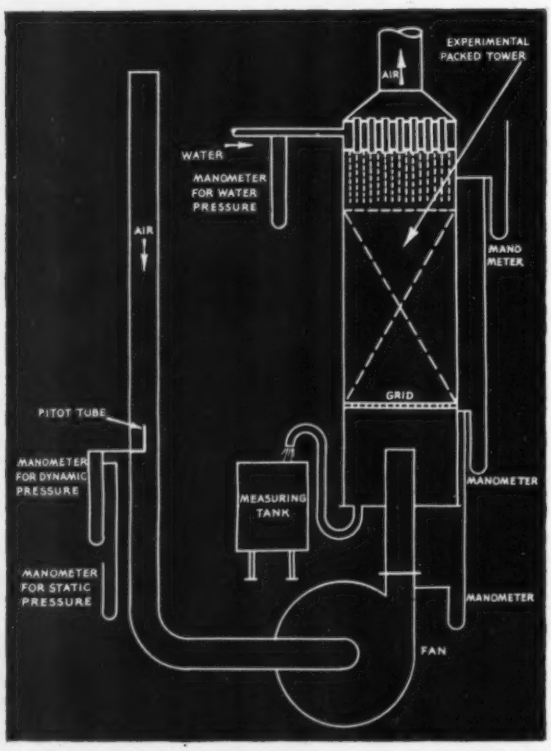
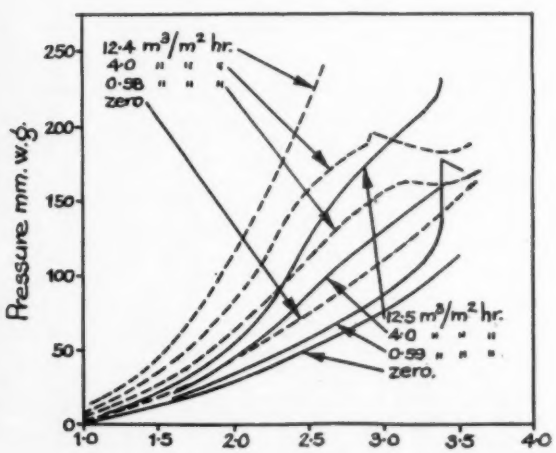


Fig. 2 (*left*). **Apparatus used by Alt, Meier and Richter for testing the performance of tower packings.**[1]

Fig. 3 (*below*). **Pressure loss as a function of air velocity and volume of irrigation.**[3] **The broken curves refer to normal rings, the full curves to pall rings; in each case the diameter is the same as the length, 50 mm.**



HEAT EXCHANGERS

A SPECIAL C.P.E. SURVEY OF SOME RECENT NEW IDEAS

Advances in Heat Transfer Knowledge

Despite the importance of heat transfer in numerous industrial processes there has been relatively little systematic research covering the whole field; the considerable attention that is now being given to this subject by the Department of Scientific and Industrial Research at its new Mechanical Engineering Research Laboratory at East Kilbride, Glasgow, is therefore to be welcomed. One of the aims is to provide more accurate basic design data for conventional and novel types of heat exchanger, and to analyse the performance of industrial heat-exchange equipment to find out what improvements are desirable and practicable.

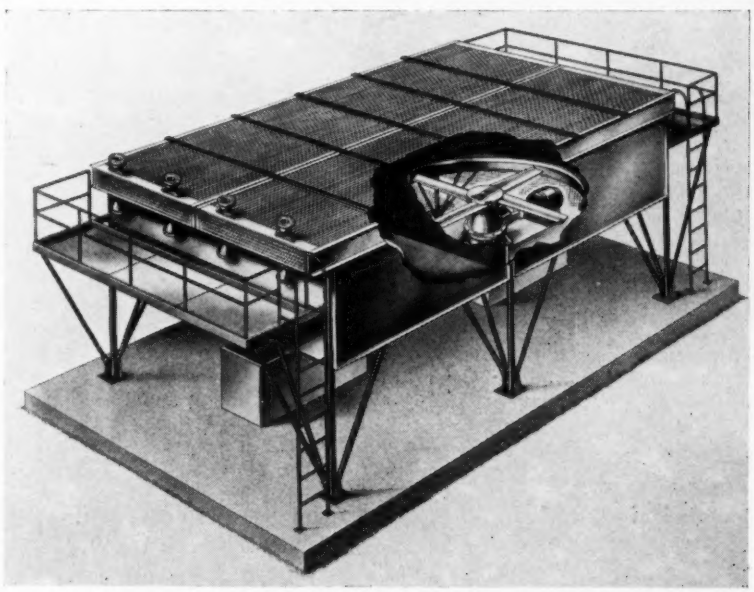
For studying the effect of discontinuities on heat transfer in pipes the experimental rigs all have certain essential features in common, namely: the pipe itself with the appropriate bend or change of section; a supply of air or water and the means for measuring the rate of flow; means for heating the pipe and for measuring the rate at which heat is transferred to the air or water; and means for measuring the temperature of the pipe and of the fluid. In all cases, heat is provided by passing a heavy electric current along the pipe wall itself, and pipe and fluid temperatures are measured by thermocouples.

Results so far obtained show that for high rates of flow the effect of a discontinuity is comparatively small and does not extend very far along the pipe. For lower rates of flow, and particularly where it is so low as to be of the laminar type, quite large effects may be obtained and may cover a length of pipe equal to 50 or more diameters. The effect of a divergence is much more marked than that of a convergence.

Dropwise condensation of steam on a cooled metal surface is known to give a very much greater heat-transfer rate than filmwise condensation. Steam can be made to condense dropwise when the metal surface is treated with certain organic compounds. Work is being carried out at the M.E.R.L. with the object of obtaining information on the life of various promoters on different metal surfaces when condensing pure and industrial steam, and of determining the effect of exposure to air (intermittent operation) on the life of the promoted surface. Other work on the application of dropwise condensation to various types of steam-using appliances is in progress and liaison is being maintained with interested industrial organisations and other Government departments.

Should Chemical Engineers Design Their Own Heat Exchangers?

Many engineers believe they can design heat exchangers and it is interesting to record the views of a specialist heat exchanger manufacturer on this point. Mr. J. A. Henley, M.SC. (ENG.), M.I.MECH.E., A.M.I.E.E., chief engineer and manager of the heat-exchange division of Wellington Tube Works Ltd., believes that many engineers tend to over-simplify heat-



'Weldex' refinery air-cooled heat exchanger designed and manufactured by the heat-exchange division of Wellington Tube Works Ltd.

exchanger design; an exchanger must not be regarded as just so many square feet of tubular surface packed into a shell. Even when theoretical aspects of thermal design are apparently appreciated, mechanical constructions are often put forward which nullify the apparently good thermal designs. Insufficient knowledge of the different materials that can be economically used often leads to over-cautious material selection, and hence increased costs. In addition, the absence of competition leads to the use of unnecessary 'over-design margins' (these should more accurately be called 'ignorance factors') which again add to cost.

Mr. Henley points out that, if equipment such as pumps, valves, motors, etc., are wanted, no engineer considers designing them himself—he quite rightly uses the services of a firm which specialises in the manufacture of these items. He recognises by his action that the pump, valve or motor manufacturer knows so much about the particular product that time, trouble and money can be saved by purchasing them from an expert. That same engineer, however, when faced with providing heat exchangers for the same plant, will often design them himself, and by so doing prevents his company benefiting from the expert knowledge and experience of the heat-exchanger manufacturer.

Normally, Mr. Henley explains, his company does not fabricate heat exchangers to designs other than the company's own because, he says, these units usually fall short of the necessary high standards. For example, it has repeatedly been found that such units are frequently designed with incorrect surface or materials, and often the mechanical construction is uneconomic. Additionally, the advantages of using extended surface, bimetallic tube, correct baffling techniques and carefully controlled clearances, etc., are often lost with an inexpert design.

Wellington have recently developed the design and manufacture of a range of air-cooled heat exchangers for refinery and chemical plant purposes. In the past this type of equipment has been manufactured only under licence to an American firm. For chemical plant, the heat exchangers are usually small and are for local mounting, indoors or out of doors. Air flow can be vertical or, more usually, horizontal, and for the indoor exchangers the exhaust may be ducted away.

For refinery and power plant, large units are available for mounting in a central position out of doors.

'Hot Salt' Heat-transfer System

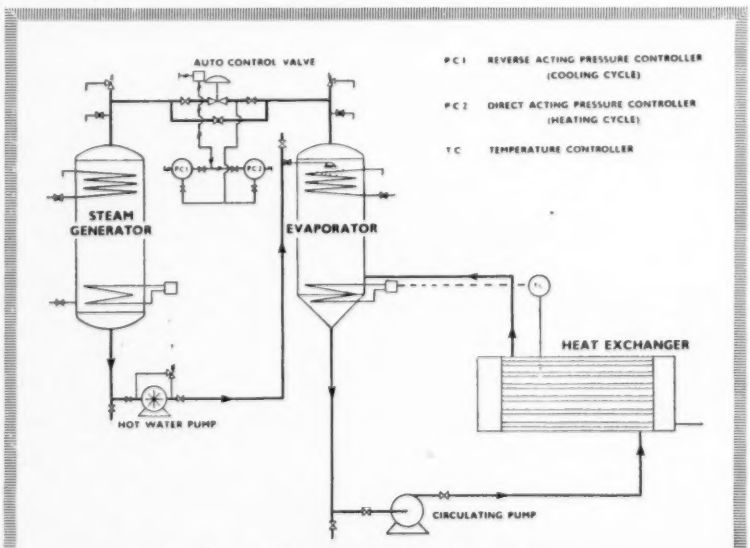
When heat transfer at temperatures above 700°F. is required, organic heat-transfer media are unsuitable and it is necessary to turn to inorganic materials. Molten inorganic salts are ideal in many ways but are difficult to manage because of their high melting points. One of the latest developments is a system in which heat is transferred by means of a medium which is solid at room temperature and into which a solvent is incorporated on cooling in order to maintain the liquid phase. The solvent is evaporated out as the temperature is increased.

In this system, developed by Hygrotherm Engineering Ltd., the circulating medium is contained in an orthodox ring main circuit and the addition or removal of the solvent is carried out at the point of lowest pressure in the system. This arrangement ensures that the stability of the fluid in the circulating system will be unaffected.

The addition and removal of the solvent is carried out under slight pressure sufficient to ensure that the boiling point of the system is higher than the melting or crystallisation temperature at any stage of operation. The process is applicable to any material for which a suitable solvent can be found. Initially it is being applied to 'HTS' potassium nitrate/sodium nitrite/sodium nitrate eutectic, which has a melting point of 285°F. and an operating range up to 1,000°F.

A pilot plant has been set up in which operational and design criteria are being evaluated.

The equipment comprises two mild-steel kettles of 25-gal. capacity, one acting as an evaporator, the other as a steam generator-condense vessel, between which steam can be passed under the control of an automatic control valve, or water can be injected as a spray into the evaporator. There is provision for a small circulatory heat-transfer system of about 5-gal. capacity which is being installed and which will be used to assess pump performance and various other design problems.

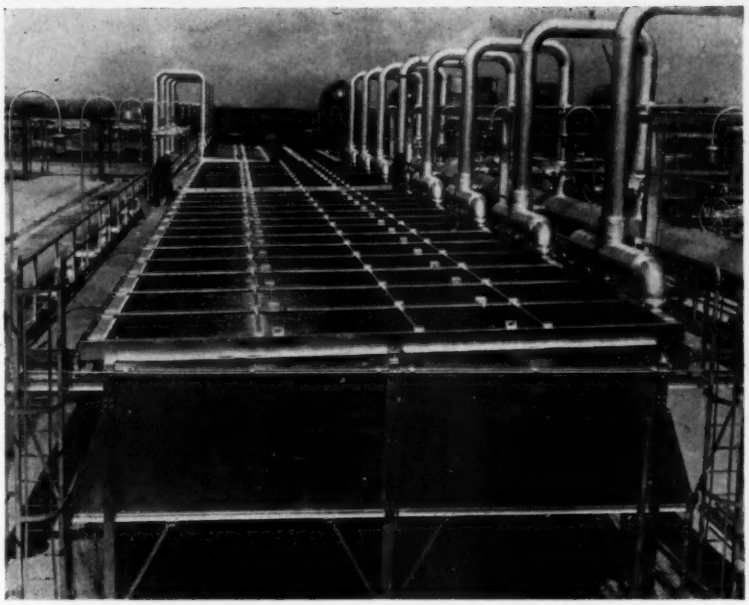


Pilot plant for studying Hygrotherm 'hot salt' system.

Outsize Heat Exchanger for Fawley

The *Fin-Fan* air-cooled heat exchanger recently installed at the Fawley petroleum refinery is claimed to be the largest unit of its kind in the United Kingdom. It is designed to cool and partially condense 225,194 lb./hr. of steam and hydrocarbon vapours from 213 to 170°F. with a heat load of 173 million B.Th.U./hr. A design ambient air temperature of 90°F. was selected to allow for the worst possible ambient conditions.

The unit is approximately 194 ft. long × 26 ft. 6 in. wide × 19 ft. 6 in. high, and 24 10-ft.-diam. fans are used to force the cooling air over the finned tubes. Power savings may be



Head Wrightson air-cooled heat exchanger at Fawley refinery.

achieved by shutting off certain of the fans when the ambient temperature falls below the design figure.

This type of exchanger finds its greatest application where suitable cooling water is scarce and expensive or where maintenance of water-cooled equipment is costly. The Fawley unit was designed and supplied by Head Wrightson Processes Ltd.

New Evaporator Uses Plates Instead of Tubes

An evaporator produced by the A.P.V. Co. operates on the climbing and falling film principle, using plates instead of tubes in an arrangement which is basically similar to that of the plate heat exchanger. The separator, also, is unorthodox since it operates on a horizontal instead of a vertical axis. This contributes to the low overall height of the plant. Feed, entering the base of the inlet section at an automatically controlled rate, boils on contact with the heated plates and rises to the top, where it transfers to the falling film discharge section and boiling continues. The concentrated product, together with the vapour, is carried into the separator where centrifugal separation takes place, followed, in a single-effect unit, by product withdrawal and the removal of vapour to a condenser.

Condensate from the steam side is also pumped from the machine and returned for boiler feed make-up.

Considerable steam economy is obtained by using double-effect evaporation preheated feed entering the first effect through an automatic flow controller and boiled under vacuum by steam at or near atmospheric pressure. The product is then pumped into the second effect where it is boiled at higher vacuum (lower temperature) by the condensing vapours from the first separator. Further concentration takes place, the resulting vapour being withdrawn from a second separator to the condenser. Vacuum is maintained throughout the plant by a two-stage steam ejector and product withdrawal is automatically controlled.

Additional steam economy is achieved by introducing thermo-compression at the first effect. Thermal efficiency can also be increased by utilising waste effluents to preheat the feed in conjunction with a plate-type heat exchanger or by passing the vapour separator discharge through a tubular preheater.

Heat Exchangers for Rare Media

When heat exchangers are required for rare media the designer endeavours to combine a large surface with a minimum volume for the rare medium. A special type of heat exchanger has been developed for such applications where centre bars are inserted in the tubes to give an annular space. By varying the diameter of the centre bars the heat exchanger can be adapted to suit any fluids or liquids.

The German firm concerned with this development, Maschinenfabrik Augsburg-Nürnberg A.G., report that five heat exchangers of × 10 Cr Ni Mo Ti 1810 material are being manufactured at their Gustavsburg works for the Karlsruhe reactor where they will be used for cooling heavy water (D_2O). Their total heating surface is 515 sq. m.

Novel Exchanger for Linoleum Manufacture

An unusual heat-transfer problem posed by a linoleum manufacturing firm recently led to the design of a unit which may well lend itself, with suitable modification, to a wide variety of applications in industry wherever the controlled attainment and steady maintenance of a process temperature is important.

The problem involved not only heating and cooling but also very carefully controlled conditions of time and temperature. The firm approached, Heat Exchangers Ltd., have, as a development of their other work on the design and fabrication of heat exchangers, engineered a number of units, primarily for use in conjunction with electronic valve equipments, where a uniform ambient temperature within the cabinet is of vital importance for preserving uniform valve characteristics. This seemingly unrelated side of their activities proved extremely useful in the current problem, as the basic thermal design characteristics were already well known.

As it was first posed, the problem was to heat a cast-iron roll to a given temperature or cool it from this temperature using 80 lb. steam and mains water as the heating and cooling media. The roll manufacturers had stipulated that the rate of rise or fall of the roll skin temperature should not exceed 1°F./min., to avoid any possibility of thermal shock and consequent damage to the roll.

The initial scheme called for a heat exchanger of the shell and tube type, with water in the tubes being circulated under pressure by a pump through the roll, as a closed cycle. The process steam, on the shell side of the exchanger, heated the water to the required temperature. For cooling, the steam was to be shut off and cooling water turned on, interlocks being provided to prevent any possibility of mixing. It was thought at

first that the capacity of the closed-circuit water system could be so arranged as to provide a 'heat sink' sufficiently large, in conjunction with the mass of the roll, to prevent the rate of rise or fall of the skin temperature from exceeding the limits laid down. On investigation, however, the volume of water required was found to be so great that the resulting heat exchanger was uneconomical in size and in addition proved difficult to accommodate in the space available in the client's plant.

A fresh appraisal was then made, which resulted in the designing of a much smaller heat exchanger, again operating with closed-cycle water in the tubes and process steam or cooling water in the shell. The controlling of the rate of supply of heating steam or cooling water was taken over by a programme controller, which was, in essence, a cam-operated thermostat. This had the further advantage that, if at any time a change was made in these rates, the programme controller could be modified without much difficulty to provide the new characteristic. In conjunction with this basic equipment of exchanger, pump and controller, a full range of interlocks and 'fail-safe' thermostatically controlled valves was provided to obviate any possibility of damage to the roll and to render the operation of the complete equipment, which was supplied as a totally-enclosed 'package' unit, as simple and foolproof as possible.

The operating temperature of the roll can be maintained at $\pm 1°C$.

Manufacture of Braun Exchangers in the U.K.

An agreement to manufacture Braun tubular heat exchangers (based on the principles established by C. F. Braun & Co., U.S.A.) has recently been concluded by Ashmore, Benson, Pease & Co., an associate company of the Power-Gas Corporation. These exchangers perform in all the usual heat-transfer services for petroleum and chemical processing, and standardised features make it possible to interchange parts of different exchangers of the same type and pressure class.

A feature of the standard exchanger is that the annular distributor directs the flow towards the tubesheet, so that there is no dead surface. The nozzles are welded to the annular distributors, which prevents distortion of the shell and permits the use of a small clearance between the shell and the cross-baffles. Small clearances reduce cross-baffle leakage and thus the performance is greatly improved.

The use of through-bolted floating heads in these exchangers will be welcomed by refinery maintenance staff, while another advantage can be seen where the cross-baffles on a bundle must be replaced, or where an exchanger goes into a different service and the cross-baffle spacing must be changed. With through-bolted floating heads, the tubes can be cut off behind the tubesheets and the bundle rebuilt with the shortened tubes.

Wrought Aluminium Bronzes as Materials of Construction

Designers and manufacturers of tubular heat exchangers, long aware of the high strength and excellent corrosion resistance of the aluminium bronzes, have hitherto had to restrict their use of such metals because, although forged tube plates had proved their usefulness for a number of years, floating head covers, liquid channels, branches, shells and similar components were only available as castings, difficult to produce and not always satisfactory. A range of wrought aluminium bronzes is now available for the fabrication of pressure vessels and heat exchangers and is claimed by the suppliers, N. C. Ashton Ltd., to be sufficient to cover the complete construction of any type of plant. Tube sheets and end plates are forged individually as discs up to any required thickness, with a maximum diameter of approximately 5 ft. Hot-rolled plate is available up to 12 ft. wide. Rolled rings can be produced to any required size.

Welding at first presented difficulties and early attempts produced problems of alumina entrapment, leading to resistance to fluxing, but almost at the same time as Murex Welding Processes Ltd. developed successful electrode coatings, inert-gas-shielded welding was introduced. Now both processes are available to produce sound welds. Single-phase aluminium bronze wires are easily manufactured, as the alloys are readily cold-drawn, but multi-pass welds produced with single-phase wires were prone to weld cracking and were low in strength. Duplex alloys are difficult to produce in wire as they cannot easily be cold-drawn, but production techniques have been developed which make possible sound multi-pass welds with over 40 tons/sq. in. U.T.S. and 30% elongation. Furthermore, it is claimed, these duplex welds have high ductility at elevated temperatures.

Fuel economy in a textile factory

Improvements in steam utilisation and the installation of a heat exchanger to extract heat from effluent have cut fuel consumption by 20% at a Scottish textile factory where steam is provided by two Lancashire boilers and one standby, using small coal—'washed gum'—with natural draught hand-fired grates. Before modification, the water for the keirs (in which the yarn is boiled prior to bleaching) was heated by direct steam injection. No lids were fitted to the keirs and the steam flow was manually controlled; steam consumption was, as a result, heavy and erratic.

The first step towards greater efficiency was to fit lids to the keirs. Calorifiers, circulating pumps and thermostatically controlled valves were installed by the firm's engineers for use in addition to the direct steam injectors, and a system of warning lights working in conjunction with thermometers and timers was introduced to assist the operator controlling the process. These improvements saved 8.6% in fuel costs.

A heat exchanger of the spiral plate type was installed to use the effluent—previously discharged to waste at 204°F.—to heat incoming supplies of fresh cold water. The heated fresh water is stored in a lagged tank, where it is further heated to operating temperature by direct steam blowers.

To compensate for the intermittent discharge from the keirs the effluent is received in an intermediate tank where a float switch controls both the operation of the effluent and the cold water pumps as well as the isolating valves. Installation of the heat exchanger has not only reduced the amount of steam required for the process but, in conjunction with the modified boiling procedure, has levelled out the steam demand on the boilers, with a consequent saving in fuel.

These details were given in a recent issue of *Target*, which identifies the factory where these modifications were introduced as that of the Claverhouse Bleachfield, Dundee, operated by Boase & Co. Ltd., a subsidiary of Baxter Bros. & Co. Ltd.

Instrumentation of a Chemical Process

By A. Pollard, B.Sc., A.R.I.C., A.M.I.Chem.E.

(Department of Coal Gas and Fuel Industries with Metallurgy, Leeds University)

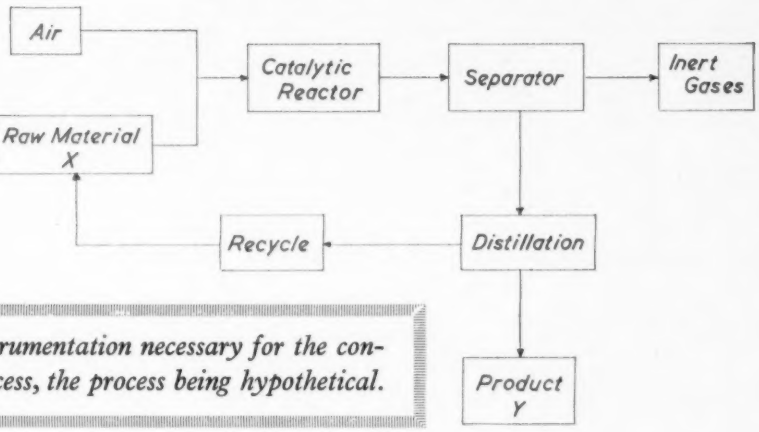


Fig. 1. This imaginary process is taken as an example for the purpose of illustrating the application of automatic control.

This article discusses the instrumentation necessary for the control of a simple chemical process, the process being hypothetical.

IF a chemical process plant is to be automatically controlled, consideration of this at the design stage is essential. The idea that instruments can be added to the plant during, or even after, erection has now almost disappeared and there is, in fact, a noticeable tendency—probably not unconnected with the current emphasis on automation in other industries—towards excessive instrumentation of new plant.

This was noted by the author in an article which appeared in the June and July issues of *Automation Progress* (an associate journal of CHEMICAL & PROCESS ENGINEERING), and in which he discussed the general principles of plant control. The application of these principles to the instrumentation of a typical process is described below.

In the hypothetical process shown schematically in Fig. 1, provision is made for the vapour-phase catalytic oxidisation of a liquid X to a liquid product Y, there being no other products formed by the reaction. X is vaporised by steam heating, and the vapour mixed with air before passing over the catalyst. The oxidation reaction is exothermic, takes place at a high temperature and can be made self-sustaining by pre-heating the reaction mixture, using heat exchange with the products. The reaction conditions require an excess of the material X and about 60% of X is converted to Y. The reaction products will thus contain a proportion of unused X in addition to the product Y and the inert gases (nitrogen, etc.) from the air, it being assumed that all the oxygen is used in the reaction. It is also assumed that X and Y can be removed from the gas mixture relatively simply by condensation, and then separated from each other by distillation. The waste gases would probably, in practice, be subjected to further treatment to remove any last traces of X and Y, but this stage of the process is not considered.

The process is completely hypothetical—it was suggested by a flow sheet used in B.S. 1646,[1] illustrating graphical symbols for instrumentation—but processes of this general type, combining a chemical reaction stage with one or more physical separation stages, are not uncommon.

Control of reaction stage

Dealing with control of the chemical reaction stage first, the proportions of the reacting materials and the pressures and temperatures in the reaction vessels (catalyst chambers) are determined by the equilibrium conditions and kinetics of the reaction. The primary control of the load on the process acts on the rate of flow of the liquid X to the vaporiser; the amount of air required is then a simple proportion, to give the required excess of X. This assumes, however, that the composition of the materials (X and air) do not vary. Whilst this may be warranted for the air, the composition of X is likely to vary since part of the supply is recycled from the distillation unit and this portion will probably contain small quantities of the product Y. Thus the proportionality between the flow of X and the air may have to be adjusted during operation, to take into account the change in composition of X. X is vaporised before mixing with the air, by steam heating in a shell and tube heater. The temperature of the vapour is a sufficient indication of the completeness of vaporisation and would be used to regulate the steam flow to the heater.

The reaction mixture is pre-heated by heat exchange with the products. Temperature control is essential here, to prevent either over-heating of the catalyst or the reaction ceasing due to too low a temperature. It is effected by a valve by-passing the heat exchanger, so that cold gas can be admitted directly to the catalyst chamber.

In a plant of this type the catalyst would most probably require periodic regeneration and a number of reactors would be operated in parallel, so that each could be taken out of circuit in turn, without reducing production by a large extent. The feed flow would thus require distribution over the reaction vessels in use at any time. Whilst this could be done by valves alone, if the feed to a particular reactor is to be determined by the age or state of the catalyst, a flow meter on each vessel will be required.

Liquid/gas separation

The product from the reactors passes to the condenser where *X* and *Y* are condensed out.

The temperature of the exit gas must obviously be reduced below the condensation point of the least volatile component, whilst the flow of cooling water is kept to the economic minimum. The liquid products disengage from the gas in the separator which also acts as an accumulator for the feed to the distillation column. The liquid draw-off must be regulated to maintain a working level in the separator. Finally, the pressure in the whole of the reaction system can be controlled by the gas take-off from the separator.

It will be seen that all material and energy flows are regulated by control of a suitable variable. It has been noted, however, that the composition of *X* is likely to vary and this will affect its conversion to *Y* and so change the composition of the liquid product. Whilst this could be dealt with in the subsequent distillation unit, steadier operating conditions will be preserved in this part of the plant if the composition of the product of the first stage can be held almost constant. There is, then, need for a supervisory control of the composition of the liquid mixture of *X* and *Y*.

If this quantity can be measured sufficiently quickly, it can be used as a control parameter by which to adjust the reaction conditions (*i.e.* either the proportions of raw materials, as already suggested or, possibly, some other variable, such as the temperature in the reaction vessels).

Automatic control

To convert the system to automatic control, the link between each point of measurement and regulation now becomes the automatic controller, in place of the human operator. This is schematically shown in Fig. 2. Simplification can be effected at one or two points, *e.g.* the control of the air flow can be transferred to a ratio controller (FRC-2), operated by the flow of *X*. Adjustment of the process load is now carried out through the desired value of the flow controller, FIC-1. The overriding control of product quality can be made automatic only if automatic analysis is available. In a simple case, the density of the liquid mixture would be determined by the proportions of *X* and *Y* and a density measuring instrument (AnI - 1) is shown in Fig. 2. This, through the associated controller (AnRC-2), is used to alter the reaction conditions by resetting the ratio of the raw materials through the ratio controller (FRC-2). Ratio control can also be used to apportion the flow of reaction mixture between the catalyst chambers. This is done by FRC-3.

Automatic control of distillation unit

In the control of the distillation unit, the same general principles of material and energy balance apply. The feed to the unit is now the output from the preceding stage and whilst this could be accumulated in tanks for independent feeding, continuous throughput is more usual practice. The feed to the column is then virtually uncontrollable since it consists of the output from the first stage. It is essential, however, in the interests of smooth operation of the column, that any changes in flow should take place relatively slowly. The separator after the chemical stage is, therefore, used as a feed accumulator, the level in this vessel being used to regulate the flow to the column by an averaging level control. The other material flows in this section are the top and bottom products and the reflux return. The bottom product must, of course, be determined by the level in the still base or reboiler. If it is assumed that the product *Y* is the less volatile component of the feed mixture, then it will be the bottom product; and the top product will be allowed to vary in order to maintain a uniform bottom composition.

The regulation of the heat supply to the base will be determined by the composition of the bottom product as indicated by the temperature in the column below the feed-plate. The reflux return cannot also be controlled by temperature, so that a direct flow control is indicated, the top product take-off being determined by the reflux separator level. The two remaining variables are the column pressure and the condenser cooling water flow. The latter is best controlled by the temperature of the condensate but, under conditions of fairly constant load, manual regulation might be adequate. In this particular instance, due to the production of the feed by condensation from a gas-vapour mixture, it is likely to contain dissolved gases which would be vented from the reflux separator. The release of such permanent gases can be used to control the pressure in the column.

The application of automatic control has been discussed in previous papers[2, 3] to which reference should be made for further details.

Intermittent measurements

Turning now to the other instrument requirements, for costing purposes the material stocks would be estimated by the level indicators on the feed and product tanks (LI 1-3). The cumulative air flow measurement, if required, could be obtained by fitting an integrator to the air flow meter. The total water and steam consumptions are measured by integrating meter FI-6, and the integrating flow recorder FR-5, respectively. Orifice plates are fitted in each of the lines leading to separate pieces of equipment but no permanently connected instrument is needed. A portable unit would be fitted if it should be necessary to measure the flow to any individual plant unit.

The main points for maintenance checks in a process of this type are the catalyst beds. The condition of the catalyst would be indicated by the temperature distribution and multipoint instruments are provided for this purpose. Whether these should be indicating or recording can only be determined by the demands of the process or previous experience. Deterioration in the performance of the heat exchangers will be shown by changes in temperature. The pressure drop across the catalyst bed also indicates packing or channelling of the bed and plant-mounted pressure gauges should be adequate for this purpose. Additional measuring points should also be provided for trouble shooting, *e.g.* sampling points for analysis of the products of each reactor and temperature pockets on heaters and coolers. These need not be permanently connected to instruments, but the inclusion of these facilities during plant erection may be most useful during commissioning and operation.

Safety requirements call for feed valves to close and product valves to open on instrument failure. Steam valves will close and cooling water valves open. Cutting off the flow to the catalyst chambers may, however, cause local over-heating and if flow distribution valves are used these should be locked in position on failure. An interesting problem is presented by the feed to the still for, being a feed valve, this should close but, being the product take-off from the first stage, the valve should open. The simplest solution is to allow the valve to close and make use of the capacity of the separator to accumulate the, probably small, amount of product formed after the main feed has been shut off.

The main reaction vessels in this

process operate under pressure, possibly at only a few atmospheres, but pressure release valves on the reactors and the product separator, also on the reflux separator of the still, would be advisable. If the gases or vapours involved are inflammable or toxic, these should, of course, be vented well away from the plant. Catalyst troubles will be caused by excess temperatures and alarms would be provided on the reaction temperature controllers. Indicator lights would also be provided on the electrical ancillaries, such as pumps and compressors. Alarm indicators might profitably be fitted on the tank level gauges and on the cooling water supply.

A central control panel from which the operation of the whole plant is supervised is to be recommended both on the grounds of efficiency and economy in the labour force and also for the improvement of working conditions and plant layout.

Selection of instruments

Before the instruments can be specified it is necessary to consider in detail the range and the accuracy required for each measurement. The latter point requires careful appraisal since the cost of an instrument is largely determined by the specified accuracy. A careful study should, therefore, be made to ensure that the accuracy specified is not excessive.

Specification does not stop at range and accuracy, since parts of the instruments will be exposed to the operating conditions. Physical and chemical properties of the process materials, together with details of the operating conditions throughout the process, must be taken into account.

The most difficult problem in instrument specification is in deciding the type of control action required, *i.e.* two-position, proportional, proportional-plus-integral, etc. Unfortunately, this is a decision in which practical experience in this field is a most important prerequisite. It is, at present, virtually impossible to determine the complete requirements at the design stage, owing to lack of fundamental knowledge in this branch of process control. It must be admitted that there is still much rule-of-thumb procedure, based on practical experience of general control problems, and knowledge of similar plant. With this it is possible to assess the requirements intelligently and suggest the basic types of controllers required. On an existing plant, some experience of the response of the controlled variables will already be available and it will also be possible to carry out experimental tests which will at least indicate the general requirements.

There remains the problem of adjustment of the instruments to give the performance required. Control equipment also includes the valves

(*Concluded on page 293*)

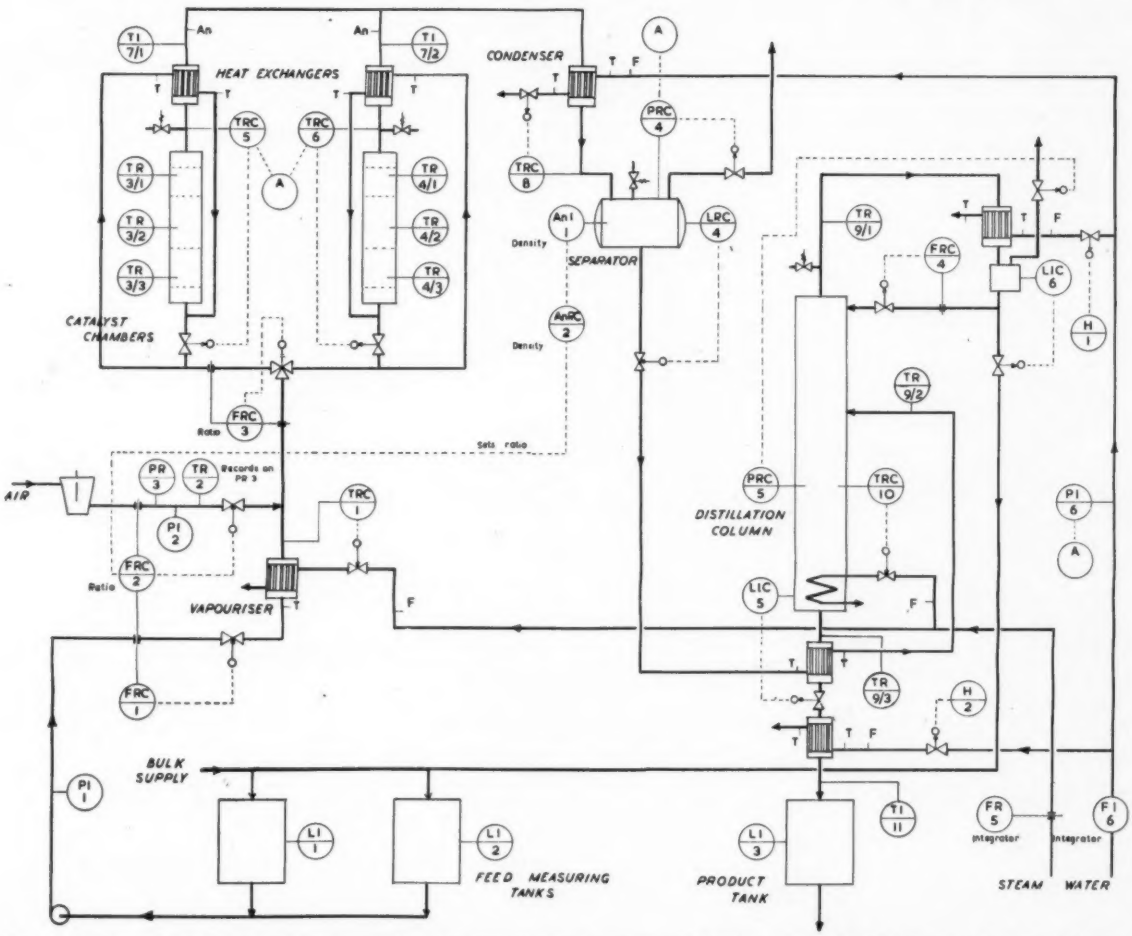
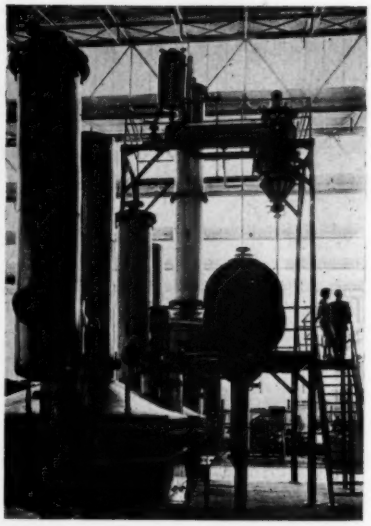


Fig. 2. A proposed scheme for instrumenting the hypothetical process outlined in Fig. 1 (symbols according to B.S.1646), using as much automatic control as is economically justifiable.

Looking Back at the

ACHEMA

▲ **The proprietors of CHEMICAL & PROCESS ENGINEERING had the distinction of being the only British publishers with a stand at the Achema.**



▲ **Exhibits on the Fried. Krupp stand.**

▲ **The British Ambassador** (*centre right*) **visits the Steele & Cowlishaw stand.**

Typical of the exhibits was this new centrifuge shown by Maschinenfabrik Burckhardt A.G., a feature of which is the simple manual control and clear indication of the setting of the jets. ▶

Adhesives from Rubber

Dunlop Rubber Co. have recently brought into full production at Castle Bromwich, Birmingham, a new factory for the manufacture of adhesives, emulsions, reclaim dispersions and latex compounds. Features of the factory, described in this article, include an impressive battery of ball mills, some heavy-duty mixers, elaborate solvent recovery arrangements and specially designed vulcanising tanks.

THE new factory at Castle Bromwich belongs to Dunlop's compositions division and is turning out adhesives at the rate of 2 million gal. p.a.; *Polimul* emulsions at the rate of $1\frac{1}{2}$ million gal.; latex compounds, $1\frac{1}{4}$ million gal. and reclaim dispersions, half a million gallons. There are three processing plants: the main adhesive plant, which produces adhesives of the solution type and includes plant for the manufacture of reclaim dispersions; a plant for the manufacture of latex compounds; and the *Polimul* plant (not yet transferred from the division's old factory buildings at Fort Dunlop) for polyvinyl acetate, polyethyl acrylate, polymethyl acrylate and similar types of synthetic resin emulsions. In addition to the factory proper, there is the administrative block, which houses the offices and laboratories.

Laboratories

The development laboratories are staffed by a team of 30 scientists and technologists and backed by the large Dunlop research centre only a mile away where the fundamental aspects of research are handled. Both laboratories are served by a fully equipped pilot plant, which includes a rubber mill, a three-roll paint mill, several machines for the manufacture of experimental solutions, a colloid mill, a ball mill, a Hobart mill for experimental latex foam work and so on. There are also machines for the manufacture of footwear for testing experimental footwear adhesives.

'Polimul' plant

This is a self-contained plant in Fort Dunlop with an area of 15,000 sq. ft. *Polimul* emulsions are used in the manufacture of textiles, paint, flooring, paper, adhesives and leather finishes. The range consists mainly of various types of polyvinyl acetate emulsions, but also includes copolymer emulsions and emulsions of polyethyl, polymethyl and polybutyl acrylate.

Adhesive plant

This plant covers an area of 26,000 sq. ft. and consists of a wide variety of solution hoppers to which the solvents are directly piped. Each hopper is fitted with solvent vapour extraction equipment, the vapour being reclaimed in a solvent recovery plant. There is also a line of rubber mills for treating the raw rubber and rubber compounds from which adhesives are made. Many solutions are bulked in large tanks for final adjustments before being decanted into containers. A considerable amount of floor space is devoted to tubing machinery for the provision of a wide variety of adhesives in tubes. The adhesives plant also contains a battery of very heavy-duty mixers for the manufacture of reclaim dispersions.

A group of solution hoppers at the Castle Bromwich adhesives factory, showing the solvent delivery pipes and solvent vapour extraction ducting.

The solvent-based adhesives produced by this plant are formulated from natural, synthetic and reclaim rubbers and natural and synthetic resins. The main industries served include the motor and coach building industry; the building and flooring industry; the footwear industry; and the textile, shipbuilding, aircraft and packaging industries. Outside these major groups there is a whole host of applications for adhesives in the industrial field, including furnishing, fancy goods, clothing and light industrial uses.

The manufacture of what is known as 'reclaim dispersion,' artificial latex prepared from reclaim rubber, has grown immensely, following the new uses found for it in backing felts and carpets and in the manufacture of certain types of carpet underlay.

Latex production

The new latex plant has been designed for the rapid and efficient preparation of adhesives and compounds based primarily on natural and synthetic rubber latex and artificial dispersions of synthetic rubbers. It occupies a floor space of 11,000 sq. ft.

Latex is delivered by road tanker from the parent company's tank installation at Liverpool and stored in five tanks each of 7,000 gal. capacity. A battery of 14 ball mills provides the dispersions of sulphur, zinc oxide, accelerators and colours used in the compounding of prevulcanised and vulcanising latices for carpet backing, dipping, latex casting compounds, etc. An ultrasonic device is used for the preparation of dispersions of the solid

A rubber dough being decanted from a large mixer.

compounding ingredients used in backing compounds for tufted carpets. The plant is also equipped with colloid mills for the dispersion of liquid ingredients and high speed stirrers for the compounding of small batches.

An interesting feature of the plant is the two 500-gal. vulcanising tanks specially designed by the division's engineers. They are fitted with variable speed stirrers and are jacketed for controlled heating. They are also designed so that a vacuum can be applied to remove any air introduced in the mixing process which might cause defects in the finished product.

Latex compounds have a very wide range of applications, most important being in the manufacture of tufted carpets, non-woven fabrics, furnishing upholstery (rubberised hair), building, surgical goods, toys, fancy goods, and window display models. The Dunlop range includes types based upon both prevulcanised and vulcanising latices. In the case of the former, the latex is cured in its liquid state; whereas to effect the cure in the latter it is necessary to carry out a heat treatment after the drying of the latex.

New developments

The division is now marketing a new polar synthetic rubber latex, *Politone* K.745, which has been developed at the Dunlop Research Centre and for which a wide range of industrial uses is predicted. It is an oil-resistant copolymer containing butadiene, and possessing properties similar to a butadiene-acrylonitrile copolymer of medium acrylonitrile content. It is expected that *Politone* will be of use in applications where oil resistance and heat ageing are important requirements and industries likely to be interested include the rubber and plastics industry, where it has been successfully tested for the dipping of protective gloves and insulating sleeves; the textile industry, where the abrasion resistance of rayon, gaberdine and cotton can be considerably improved by the application of *Politone*; and the paper industry, where the incorporation of *Politone* enhances the wet strength, edge tear strength, elongation and flexibility of paper.

CO_2 Removal and Recovery

(*Concluded from page* 273)

out the promise of economically bringing the CO_2 down to even lower limits.

A combined hot potash/amine scrubbing system is an attractive possibility where large quantities of high CO_2 content gas under pressure are to be treated for complete purification. A flow diagram of such a system is shown on Fig. 3 which relates to a synthetic ammonia plant. The synthesis gases are produced at high pressure by the partial oxidation of a hydrocarbon stream: nitrogen from the air liquefaction plant is to be used for final purification. Synthesis gas enters the absorption system where the CO_2 content is reduced to 2% by hot potash washing, subsequent amine absorption bringing the figure down to 0.02%. A caustic wash completes the removal of the CO_2. The alternative of water washing is normally excluded by reason of the fact that it only reduces the CO_2 content at best to a minimum of 0.2% and the cost in caustic soda of lowering this to the not measurable state is prohibitive. Elimination of the CO_2 is essential at this stage to preclude the possibility of solid CO_2 depositing on heat exchanger surfaces, etc., during the low-temperature liquid nitrogen washing.

The two-stage system, as described, is less costly in steam than either straight amine scrubbing or than the combined cost of steam and caustic for hot potash alone. Steam savings more than compensate for higher capital costs.

We are grateful to the Power-Gas Corporation Ltd. for permission to publish the foregoing article, which originally appeared in The Power-Gas Group Review *for May* 1958.

The Leonard Hill Technical Group—August

Articles appearing in some of our associate journals this month include:

Manufacturing Chemist—Safety in the Chemical Industry; Wetting Agents for Agricultural Sprays; Perfumes for Cosmetics, 2; Silicone Polishes; Lemongrass Oil from Ceylon.

Corrosion Technology—Propeller Corrosion and Cavitation Erosion; Cathodic Protection of Ballast Tanks; New System to Beat Hull Corrosion.

Petroleum—Review of European Petroleum Industry; Holland as an Oil Country; Petroleum Prospecting by Microbiology; Oil and Natural Gas in Italy; Separation of Gases in Oil Refineries.

Paint Manufacture—Surface Coatings Derived from Tall Oil, 3; Fading of Printing Inks; Glycerol in Inks; Japanese Printing Ink Industry.

Atomics & Nuclear Energy—American Civilian Power Reactor Programme; American Prospects for Economic Nuclear Power; Sodium Graphite Reactor; American Developments in the Use of Zirconium; Ceramics in Nuclear Energy.

Dairy Engineering—Glass for Pipelines; Towards Dairy Automation, 2; Notes on Rinsing Techniques.

Food Manufacture—Modern Trends in Factory Lighting Equipment and Maintenance; The Problem of Improving Nutritive Value.

World Crops—How A Selective Herbicide Works; Scrub Clearance by Chemical Means.

Chemical and Engineering Advances

RECENT BRITISH RESEARCH SUMMARISED

AN expansion of the present programme of inorganic chemistry, particularly for research on high-purity materials, is urged in the annual report of the Chemistry Research Board, presented to the Council for Scientific and Industrial Research recently. The report recommends that plans for the next five-year period should include the provision of buildings, equipment and staff for greater effort in these and other directions.

Subjects on which the Board has carried out research include the following:

Chemical engineering

The rate of solution of a gas in an agitated liquid is being studied because this rate process determines the overall rate of many industrial operations, including sometimes that of fermentation. Since the area of contact between gas and liquid largely determines the rate of solution of gas, work has been directed towards means for measuring this quantity. In addition, it is necessary to evaluate mass-transfer coefficients if a complete prediction of equipment performance is to be made, and some progress has been made in this direction.

An optical device has been tested and found to be satisfactory for the measurement of the interfacial area in dynamically maintained gas-liquid dispersions. In this, a beam of parallel light is passed through the dispersion on to a photocell placed some distance away from the dispersion. By positioning the photocell in this manner the light which is scattered by gas bubbles, at various angles from the incident light path, is avoided by the photocell, which 'sees' the gas bubbles as black discs. With this arrangement only that part of the incident light beam which meets no obstruction is recorded, and a relationship has been recorded which appears to be true when tested with suspensions of polystyrene and glass beads in water and with bubble clouds of known properties. A compact measuring instrument utilising these principles has been constructed.

Some measurements of the liquid-phase mass-transfer coefficients obtaining in aerated mixers have been carried out by observing the rates at which oxygen and benzene are desorbed from their agitated aqueous solutions, by air. In all cases the interfacial areas were known from previous measurements, already described.

The results, as yet incomplete, lead to the following conclusions:

(1) The liquid-phase mass-transfer coefficients in aerated mixers are the same as those found for other gas-liquid contacting devices (*e.g.* sieve plates).

(2) Those solutes which increase the interfacial area by their presence also reduce the value of the mass-transfer coefficient, so that generally, no improvement in performance is realised.

(3) Some diffusing substances (*e.g.* oxygen) give mass-transfer coefficients, whose values may be predicted on the assumption that there is no skin friction between gas bubbles and the liquid through which they move. Other diffusing substances (*e.g.* benzene) give mass-transfer coefficients which agree with values reported for mass-transfer from solid spheres where the skin friction is appreciable.

These results imply that the presence of certain solutes at the gas-liquid interface increases the skin friction between the two phases and thereby reduces the mass-transfer coefficient.

Inorganic chemistry

Examination of the operating conditions of the ion-exchange method of separating the rare earths has resulted in the isolation of most of the earths with purities of 99.9% and in building up considerable quantities of concentrates. A rapid method of concentrating the less plentiful constituents of rare-earth mixtures using a partial chromatographic technique has been developed. Further studies of zone refining as a means of producing the highly pure elements now required by the electrical industry, have revealed that in some cases the method is not effective in removing all the impurities. For instance, selenium remains in tellurium, lead in indium, antimony in tin and arsenic in antimony; in the first two examples, however, chemical conversion to salts followed by zone-melting led to a reduction of the impurities.

The possibility of recovering germanium from ammoniacal liquor has been examined; the concentration of the element in the liquor is only some 2 to 3 p.p.m. but the large volumes of liquor produced annually could yield several tons of germanium if recovered. Samples from gas works seem to vary appreciably in composition and no single co-precipitating agent has been found which is effective in all cases. Recovery of germanium by co-precipitation is possible, however, with all the liquors examined and this source could provide notable quantities of the metal if necessary.

Sulphur from sewage sludge

The pilot-plant trials of the microbial production of sulphur from sulphate-enriched sewage sludge, being carried out by the London County Council at Beckton, London, have confirmed earlier experiments in that the final sludge 'dewaters' more efficiently than sludge digested for methane. This fact may well have an important influence on the economics of the process, and in addition the trials have provided essential information for the design of larger semi-scale plant.

Extraction and concentration of thorium

Work has been carried out on the possibility of recovering thorium from sulphuric acid monazite leach liquors by selective oxalate precipitation. Bench-scale experiments have resulted in a method giving a 90 to 95% recovery and a product containing virtually no phosphate and a thorium/rare earth weight ratio of 5 : 1. Precipitation is effected by the addition of a 100% stoichiometric excess of oxalic acid to diluted leach liquor containing 12 to 14% v/v sulphuric acid. In order to obtain a product of the purity mentioned it is necessary to digest the precipitate with a fresh sulphuric acid solution. A flow sheet for such a process has been prepared.

Thorium can be recovered from sulphate solutions by solvent extraction using phosphate esters or amines; ferric iron normally interferes with phosphate extractions but has no effect when amines are employed. In work with synthetic sulphate liquors none of the difficulties experienced with uranium through the formation of a third phase have occurred. Solvent extraction has been successfully applied to the recovery of thorium

from synthetic uranium-plant barren liquors and so promises to make available an economically attractive source of thorium. Di-(2-ethylhexyl) hydrogen phosphate was the most satisfactory of the phosphate esters tested but recent work has indicated that certain amines are preferable. A continuous counter-current technique almost identical with that used for uranium extraction has been used.

Organic chemistry and high polymers

Measurements of the fundamental thermodynamic properties of highly purified specimens of compounds of scientific and industrial importance will be made more complete by the work at present being initiated on the direct measurement of specific heats and latent heats of vaporisation. The increased effort on truly selective ion-exchange resins has permitted several new sources of chelating and complexing resins to be examined.

With the support of the National Research Development Corporation, the work on ion-selective membranes has been intensified. Encouraging progress is being made in the preparation of new types of these materials, which are of considerable importance in dialytic and electrodialytic processes.

Corrosion studies

Failure of tubes by corrosion in water-circulating cooling systems of modern engineering projects may result in serious stoppages. Three experimental water-circulating systems have been constructed to study this problem and an experimental technique is being developed to obtain reproducible results with varying flow rates and periods of time. The difficulties to be overcome include the drop in the alkalinity of the water due to deposition of calcium carbonate scale, and contamination of the water by bacteria, algae and protozoa. Knowledge gained from the fundamental studies of corrosion inhibitors already in progress will be applied to testing the effectiveness of introducing soluble inhibitors into circulating systems. The formation of an absorbed film and the subsequent growth of an oxide film have been followed by radiometric methods.

RECENT PUBLICATIONS

Dust collection. The Sturtevant Engineering Co. Ltd., Southern House, Cannon Street, London, E.C.4, who have for over 60 years studied the problem of atmospheric pollution, have now produced the *Ludgate* multicell dust collector, capable of removing the coarser dusts arising from the use of stoker-fired boiler plant; it may also be used as a pre-collector in series with an electrostatic precipitator. An illustrated pamphlet, describing the machine in detail, is available. Also from Sturtevant is an illustrated 12-page booklet which describes their range of wet-type dust collectors and dust scrubbers, suitable for dealing with explosive or inflammable dusts. Yet another leaflet offers information about the *Newgate* collector, which deals with the disposal of grit and fly-ash carried over with flue gases, and has the special advantage of occupying only 5 cu. ft. of space.

Water pollution. The Water Pollution Research Laboratory of the Department of Scientific and Industrial Research (Elder Way, Stevenage, Herts.) has recently issued the first of a quarterly series of leaflets dealing with different aspects of water pollution and its control, and intended particularly for industry. This leaflet deals with the effect of organic discharges on the level of oxygen in a stream, and includes a short list of references.

Particle accelerators. An illustrated, 12-page booklet, published by High Voltage Engineering Corporation, Burlington, Mass., U.S.A., describes the many known and potential applications of both Van de Graaff and linear accelerators. Various applications for accelerators are listed.

Silicone coatings. Midland Silicones Ltd., 19 Upper Brook Street, London, W.1, issue a data sheet giving information about their release coatings for papers, which they are offering for trial. Details are given of the application of the finishes, their composition and appearance, and their various uses.

Hydrofining of benzole is the subject of a pamphlet by International-Carl Still Ltd., 19 Woburn Place, London, W.C.1. The *Hydrofining* process is described, and the British and American specifications for benzole compared; there is a section on influences affecting the process. The discussion deals also with the extraction of coke-oven benzole.

Acetone: primary product or by-product?

The history of acetone production demonstrates how during a period of time the status of a chemical may vary from that of a main product to a by-product. At the present time it seems reasonably possible that total by-product acetone in the course of the next ten years will substantially exceed that produced as the main product of synthesis. Thus, over a span of less than 50 years, acetone, originally a by-product, became a main product, then soon it was back to a by-product status on a new base. Again, by the development of a new cheap synthesis it became a main product and grew very rapidly in tonnage. Today, new developments are producing acetone as a by-product and these may grow to the point of dominating the market again.

These trends were noted by Mr. J. M. Weiss in *Chemical Engineering News*, 1958, **36**, (23), 79-82. He points out that the fermentation process for acetone has retained a lesser and lesser proportion of the acetone market. The co-product, butyl alcohol, has also been made by synthesis. Hence, the fermentation process has steadily contracted and may be considered almost obsolete.

In recent years there have been several developments which tend to reverse the situation and increase the proportion of acetone obtained as a by-product of other operations. One is the partial oxidation of propane and butane to produce a variety of oxygenated products of which acetone is one. A more important producer of by-product acetone in substantial amount is the cumene process to produce phenol.

Mr. Weiss notes that the total capacity for phenol by all processes is at present in the neighbourhood of 600 million lb. p.a., so that if all were produced by the cumene process there would be 360 million lb. of by-product acetone or about 55% of the total 1957 acetone production. This, however, appears quite improbable. The cumene process is not likely to be installed to replace plants by the older processes which have been operating for years and are largely depreciated. New capacity, on the other hand, may well adopt the cumene process, so we will probably have a gradually increasing availability of by-product from this source.

No wonder, Mr. Weiss remarks in conclusion, that the factor of obsolescence in the chemical industry is a high one.

WHAT'S NEWS about

★ Plant
★ Equipment
★ Materials
★ Processes

This illustrated report on recent developments is associated with a reader service that is operated free of charge by our Enquiry Bureau. Each item appearing in these pages has a reference number appended to it; to obtain more information, fill in the top postcard attached, giving the appropriate reference number(s), and post the card (no stamp required in the United Kingdom).

Drier and air conditioner

A mobile unit, designed primarily for the drying of wheat, seeds, sugar, chemicals, etc., in bulk, is claimed to have a wide range of applications, especially in the drying of materials where the use of heat would be detrimental.

The principle of this apparatus is to force, in an enclosed circuit, a current of air loaded with moisture through a cold surface, thus condensing such moisture into water. The air is then passed through a warmer surface and the cycle is repeated, air being recirculated in a warm and dry condition by means of a powerful turbo ventilator. It can also be used to dry the atmosphere of a store room requiring the extraction of moisture.

Should only cold and dry air be required this can be achieved by the manipulation of a few valves and the use of an extra condenser; in both cases the reconditioned air passing through any material or used freely in an enclosed space is dry regardless of the exterior atmosphere.

Selling agents in Britain are the Cold Stream Engineering Co. Ltd., who state that larger, permanent installations are also available.

CPE 958

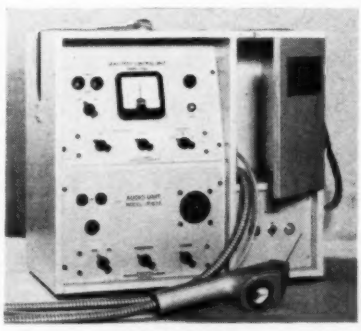
New gas detection unit

The GD1 gas detection unit has been specially developed for dealing with the outward leakage of gas from pressure vessels, chemical engineering systems, heat exchanger banks and also for vacuum installations. The apparatus is enclosed in a wooden cabinet $18\frac{3}{4}$ in. long × $10\frac{1}{2}$ in. wide × $16\frac{3}{4}$ in. high and comprises a small pumping outfit, an audio unit and an LT6 leak detection instrument which acts as an amplifier. The probe unit is mounted on a 9-ft. length of flexible tubing and incorporates a deflection meter.

Gas leaking from the system under test is drawn through the probe unit by the pump and over an electrically heated element, the temperature and hence resistance of which changes accordingly. Gas leakage is therefore indicated on the deflection meter in the probe unit and on the LT6 control unit. Where large systems or vessels are being tested, the audio unit can be put into operation so that the operator can hear a leak at some distance from the control unit. According to the makers, Edwards High Vacuum Ltd., the GD1 will readily locate leakage as small as 1/50 oz. of hydrogen p.a.

By means of a simple switch at the back of the apparatus, the LT6A leak detection control unit can be employed on any vacuum system using the hydrogen/Pirani technique. The instrument is provided with suitable connections for both the series 5 and series 6 Pirani gauge heads.

This is a new development and models will not be available for two or three months. **CPE 959**



Gas detector.

Safe liquid-level control

The R. & G. liquid-level and flow controls and alarms can be used where gases in the hydrogen and pentane classes may be present. The switching or control system is made up of two basic units, the relay unit and the level or flow switch. The former is operated from a single-phase, a.c. mains input and is enclosed in a metal case which must, in standard form, be placed outside the danger area; a flameproof enclosure will shortly be available. The latter incorporates the R. & G. magnetic drive through the solid body of the instrument, thus excluding the possibility of leakage. Further details may be obtained from the makers, Bayham Ltd., or by using the reply-paid card. **CPE 960**

Anti-white rust process

John Summers & Sons Ltd. have developed a coating for galvanised steel sheets which considerably reduces the formation of white rust; they have already incorporated it as part of their own manufacturing technique. The new process inhibits the initial reaction of unsuitable conditions on the protective zinc coating of the steel, without diminishing the brilliance of the sheet surface or reducing the spangle. **CPE 961**

Sulphur burner

The spray-type sulphur burner developed by the Kestner Evaporator & Engineering Co. Ltd. consists essentially of a specially designed atomiser and combustion chamber, generating the sulphur dioxide at high concentration.

It is claimed to have the following advantages: a high turn-down ratio, since the sulphur feed rate may be varied over a wide range simply by manipulating the feed control valve;

C.P.E.'S MONTHLY REPORT AND READER SERVICE

burner gas containing up to 18% SO_2 by volume may be readily obtained; the unit may be operated under any back pressure normally required for the processing of burner gas; and the high combustion rates in the unit permit of small demand on space, the unit being very compact. **CPE 962**

General-purpose counter

General-purpose counting equipment has been developed by a British company in conjunction with the United Kingdom Atomic Energy Research Establishment to provide comprehensive scaling facilities for Geiger and scintillation counters used for the accurate assay of alpha, beta and gamma active samples.

The basic equipment consists of two main units which may be supplemented by acccessory sub-units; the power unit provides all the power supplies, including stabilised E.H.T. The scaling unit consists of a slow scaler sub-unit and a paralysis/timing sub-unit. The equipment includes facilities for slow-speed scaling and a choice of paralysis times, as well as automatic timing control. A built-in test facility checks performance under marginal circuit conditions.

Further details of the equipment and accessories may be obtained from the makers, Airmec Ltd., or by using the reply-paid postcard. **CPE 963**

'Package' welding unit

The new L.R. 150 engine-driven welder has been designed by Lincoln Electric Co. Ltd. as a portable 'package' 150-amp. d.c. welding unit for use with the *Land-Rover*. It is driven directly from the *Land-Rover* rear p.t.-o. by a simple belt drive; it is mounted on a special frame and is quickly and easily fitted in place of the tailboard. Each unit is supplied with a set of accessories which enable welding to be commenced immediately.

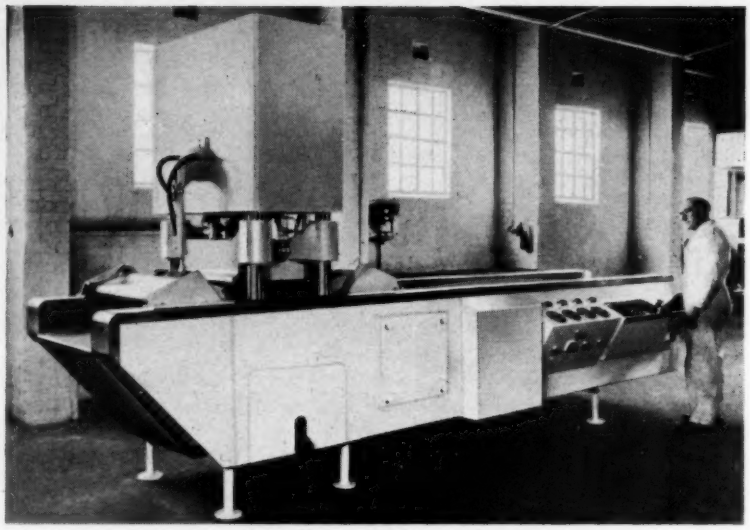
CPE 964

Pressure ratio control

A recent product of H. M. Hobson Ltd., manufactured under licence from the Solar Aircraft Co., U.S.A., is the *Microjet* pressure ratio control unit, a device which computes pressure ratio with negligible time delay. It may be used either as a pressure ratio meter or as the sensor in a pressure ratio control system, in which role it can be made to maintain a predetermined value of pressure ratio. It is claimed to be unique in that it produces an output proportional to the error in pressure ratio and is also completely independent of the absolute value of the pressures used. It is thus particularly suitable for such processes as the mixing of liquids at varying flow rates.

The equipment consists of a cast metal case containing a flexible diaphragm and attached taper needle; this indicates the amount of any deviation from the desired ratio between pressures, and may be adapted to act as a switch operating between two predetermined pressure ratios.

CPE 965



Hydraulically operated conveyor press.

Liquid-level transmitter

A new, direct-mounted liquid-level transmitter uses a force balance design to measure liquid level in open or closed vessels. It transmits an output air signal to standard 3 to 15 p.s.i. receiver recorders and controllers which may be locally or remotely mounted. The sensing diaphragm is flange-mounted to the side of the tank.

The instrument, made by Foxboro-Yoxall Ltd., is available in three forms designed to cope with the most arduous corrosion conditions.

CPE 967

STEARINE IN BEAD FORM

A completely new range of stearines of superior quality and higher chemical stability is announced by Price's (Bromborough) Ltd. These are being offered in the United Kingdom under the name *Pristerine*.

As well as the traditional flake, powder and block, the company have introduced *Pristerine* in bead form. It is claimed that stearine in this form does not dust or cake and is specially designed for fluidised handling. **CPE 966**

Automatic conveyor press

The new automatic conveyor press which has been developed and manufactured by Modern Mechanisation Ltd. is capable of expressing water, oils or juices from a wide variety of materials, both granular and fibrous. It originated from a machine which the company produced for the Rothamsted Experimental Station for the extraction of protein from green leaves.

The machine consists of an hydraulically operated down-stroke platen-type press, the bed of which is trough shaped. A conveyor belt passes through this trough which fits the platen closely. The belt, made from a filter-type cloth and supported by a wedge wire grid, is arranged to move intermittently under the press platen, thus feeding successive batches of material. The open ends of the trough adjacent to the platen are closed by means of two gates, the bed of the press then forming an open-topped box in which the platen fits closely. When the platen descends into the box, liquid is forced out of the material through the filter belt and wedge wire grid into a collecting tray and thence to suitable receptacles or pipelines.

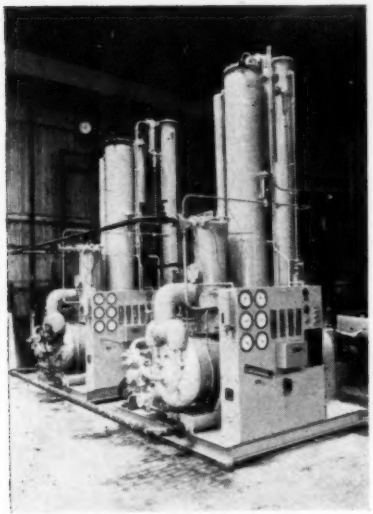
The platen is covered with a rubber pad which performs the dual function of evening out the pressure over

the whole area, thus accommodating irregularities in the density of the material and sealing the sides of the trough and the gates. **CPE 968**

Nitrogen generators

The Holmes-Kemp nitrogen generator is capable of producing nitrogen by the combustion of any of the commercial fuel gases with air. Operation can be almost entirely automatic and, according to the manufacturers, the gas produced has a degree of purity which compares favourably with that of nitrogen made by any other full-scale production unit.

Controlled combustion is achieved by the use of a carburettor which is



Nitrogen generator units.

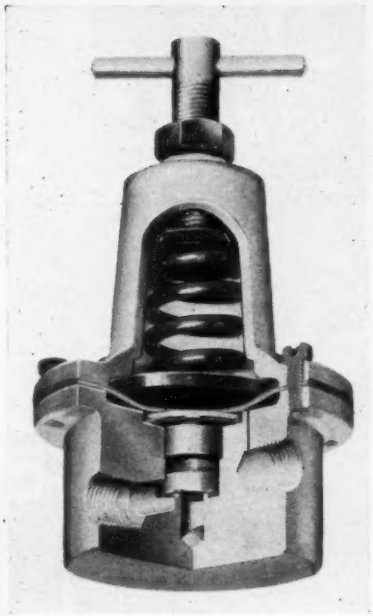
adjustable over a wide range to give varying fuel to air ratios and which is automatically responsive to demand.

The products of combustion are cooled and carbon dioxide removal is then carried out by passing the gas through an adsorber tower containing monoethanolamine. The plants are complete with re-boiler, stripper and heat exchanger for the regeneration of the monoethanolamine, thus providing a completely self-contained and a continuous system of operation.

Makers: W. C. Holmes & Co. Ltd. **CPE 969**

Coloured flooring reduces explosive risk

A special grade of gritless (*i.e.* spark-proof) grey *Colourphalt* asphalt flooring has recently been laid at a factory where gunpowder is used in the process. The new floor, being grey putty colour, ensures that the



Lock-up valve.

powder can be seen at a glance and swept up completely.

Colourphalt is pigmented mastic asphalt manufactured and laid by the Limmer & Trinidad Lake Asphalt Co. Ltd. **CPE 970**

Mercury vapour meter

Chronic mercury poisoning, 'mercurialism,' arising from the regular assimilation of Hg vapour when present in air, is now widely recognised as an industrial hazard and one which can easily have been underestimated. The *Autoset* mercury vapour meter indicates by dial readings the mercury vapour content of the air in a room or the level of Hg contamination in other gas systems. The principle employed is the absorption by Hg vapour of ultra-violet rays at a wavelength of 2,537 A.U. A low-pressure mercury resonance lamp is mounted at one end of a cylindrical chamber, at the other end of which is mounted a photocell. The chamber is kept replenished with air drawn from the atmosphere to be tested by means of an auxiliary jet pump, or the instrument may be connected directly into a low-pressure closed circuit. The radiation from the lamp passes through the test atmosphere and its intensity, as received by the photocell, is indicated on the micro-ammeter mounted on the front panel of the instrument.

Further information from Hanovia lamps division, Engelhard Industries, or from C.P.E., quoting: **CPE 971**

Electronic control of industrial operations

The electronic *Motoload* relay unit made by Radiovisor Parent Ltd. is a versatile equipment applicable to any control function which may be initiated from a current change in the feed to an electric motor, caused by varying loads or other conditions. The control of mixing in vats is given as one example of its applications. Automatic proportioning of ingredients based on the loading of Archimedean screw-type conveyors is another.

The unit is connected in series with the driving motor to be monitored and under steady load conditions the relay stays in the 'off' position. An increase in load causes an increase in motor current and the relay operates immediately to give warning of the new condition or to perform the desired switching operation.

The *Motoload* is used in conjunction with a current transformer, which has a standard output arranged to operate the electronic circuit. The connection of *Motoload* is said not to affect characteristics of motor circuit and performance. **CPE 972**

Simple moisture meter

The new Shaw constant-pressure-type moisture meter is claimed to give, by placing the sample under considerable pressure, good reproducibility of readings. The reading itself is obtained by passing high radio frequencies of over 100 megacycles through the sample. The moisture is immediately indicated on a 5-in. meter dial and there are readings from complete dryness to 100% water. The readings can be determined to one part in 1,400.

The drier the test sample the higher is the accuracy obtainable. It is claimed, further, that the instrument is not affected by density variations in the sample, or by normal electrolyte variations. **CPE 973**

Safety lock-up valve

A means of avoiding plant shutdowns due to air supply failure is embodied in a new safety lock-up device for diaphragm motor valves. The brass valve, manufactured by Crosby Valve & Engineering Co. Ltd., is connected in the air line between the control instrument and the diaphragm connection of the control valve. The signal connection of this lock-up valve is connected to the instrument air supply. When the air supply is normal the signal pressure underneath the diaphragm compresses the spring hold-

ing the valve in the open position, thus enabling the instrument output to pass straight through to the diaphragm in the normal way.

Immediately the instrument air supply pressure drops below a predetermined value the spring moves the soft-seated plug downwards, shutting the valve completely, locking the last instrument output pressure signal in the control valve diaphragm case. Provided the air line connections at the control valve diaphragm and the lock-up valve are tight, the control valve will be locked in this last position for an indefinite period, allowing the air failure fault to be located and rectified. As soon as the air supply is restored the lock-up valve will reopen and normal process control will be re-established without any major upset. **CPE 974**

PTFE for bearing surfaces

Crane Packing Ltd. of Slough have developed solid raw material forms of polytetrafluoroethylene (PTFE) in a number of grades, eight being so far available. The term 'grades' is not connotative of the quality or purity of the products, but serves to distinguish between the different properties developed in them, either by processing, or by the use of additives.

Grades 7 and 8 are examples, and contain reinforcement in the form of glass fibre. The makers claim that this addition to the basic material virtually eliminates cold flow and imparts better heat transfer properties; dimensional stability is also improved, and tolerances in the order of $\pm$ 0.001 in. are possible when machining these grades.

The properties imparted to grades 7 and 8 make them suitable for use as bearing surfaces such as bushes or thrust discs. These have been applied at maximum loadings of 40 p.s.i., temperatures up to 200°C., and at rubbing speeds of up to 1,000 surface ft./min.

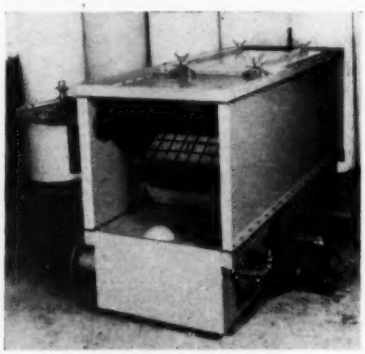
Further uses for these grades include: cylinders, tubes, rings, discs and various small moulded and machined components. **CPE 975**

New control system sets its own set point

At Colvilles' works in Ravenscraig, the first-hand melter in charge of open-hearth furnaces has a new ally—an automatic control system which integrates the control of five variables. The installation, designed and manufactured by Honeywell Controls Ltd., provides safe high-temperature operation, and automatic action when critical variables reach peak values. Among the eventualities which the control system copes with automatically are shortage of either fuel, excessive furnace roof temperatures, and the periodic need for reversal of firing.

The system exploits to the full the potentialities of cascade control—a method of instrumentation in which the set-point of a controller for one variable is determined by another 'master' controller which controls a second related variable. Cascade control provides closer control of conditions where many variables are involved, and increases the number of operations which can be carried out automatically.

On the furnaces at Colvilles', final control action is taken by separate flow controllers for oil, gas, steam and combustion air flow. The settings on these controllers are themselves determined by a total fuel controller, which continuously measures total fuel input, and compensates for any lack of either fuel by raising the set-point on the controller for the other fuel. Total B.Th.U. supply thus remains independent of random variations in oil or gas supply. **CPE 976**



FUME WASHER

This apparatus, the Manwood Miller capillary washer, is for fume removal where the chemicals are water-soluble. It is claimed that this system ensures almost 100% *contact. In the picture, the apparatus is being used for washing fume from ferric chloride.*

Further information from B.X. Plastics Ltd. or from the C.P.E. Enquiry Bureau, quoting: **CPE 977**

Sprinkler switch alarm

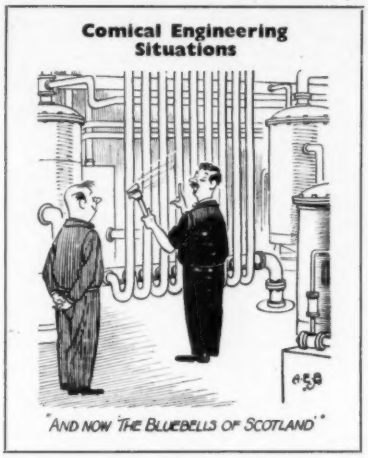
A switch which provides an automatic alarm for a sprinkler system has been developed by Sound Diffusion (Auto-Thermatic) Ltd. This device is claimed to be novel in that it gives reliable warning, while excluding the possibility of false alarms. It is completely independent of the sprinkler system and consists of transistorised circuitry incorporating audio equipment which can be triggered by means of an electro acoustic transducer mounted adjacent to the sprinker bells or, alternatively, by means of an already installed pressure switch. The delay characteristics of the circuit can be set so as to eliminate an alarm being given until a certain amount of water has flowed. Thus there is no possibility of a false alarm being originated. **CPE 978**

Standard buildings designed on 'plastic' theory

The plastic method of designing the steel framework of buildings is a comparatively new technique whereby a considerable saving of steel can be effected. It was recently stated that some 400 sizeable, single-storey buildings, designed on this method, have been erected in Britain. Over 200 of the 400 buildings referred to are claimed to have been erected by one company—Sanders & Forster Ltd.—who, since introducing their range of standard buildings in 1954, have sold over 2 million sq. ft. in area, and are at present investigating the application of the plastic method to other forms of steel-framed construction. This, it is anticipated, will be competitive with reinforced concrete even after the cost of fireproof casting. **CPE 979**

Hydraulic hoses

British-made PTFE hydraulic hoses with swaged-on or re-usable end fittings are offered by Palmer Aero Products Ltd. Constructed with exterior stainless-steel wire braid, they are claimed to be suitable for a wide range of engineering solvents, hydraulic fluids, acids and HTP. It is stated that they are unaffected by all chemicals except molten alkali metals and fluorine at elevated temperatures and pressures. Pressures quoted are from 1,000 to 10,000 p.s.i. and temperatures from -100 to $+500$°F. Further advantages claimed for these hoses are that they are non-ageing, non-flammable, water-repellent and able to withstand prolonged flexing and vibration. **CPE 980**



Instrumentation of a Chemical Process

(*Concluded from page* 283)

and these must be of the correct sizes.

In the smaller companies the question naturally arises as to who is to carry out this work of instrument specification and the later installation and commissioning. Whilst the ideal solution is for each company to employ its own specialist staff, there are other solutions to this problem. Generally, even if the plant design is done within the company, manufacture and erection of the plant will be contracted to specialists. Plant manufacturers often provide basic instrumentation as standard items, not always of the best quality.

Instrument design may also be handed over to a specialist instrument firm or to one of the consulting organisations who specialise also in this field. Both are generally satisfactory but may be expensive. An instrument manufacturer will naturally specify his own products as far as possible, which may not necessarily be the best solution to the problem; he will also generally carry out the installation, commissioning and subsequent maintenance, if desired.

As has recently been pointed out,[4] there is a need for more independent consultants in this particular field. This would help the smaller companies with this vital aspect of plant design.

REFERENCES

[1]British Standards Institution, B.S. 1646: 1950.

[2]A. Pollard, CHEMICAL & PROCESS ENGINEERING, 1954, **35**, 339; 1955, **36**, 10.

[3]J. W. Broadhurst, *Trans. Soc. Inst. Tech.*, 1956, **8**, 1.

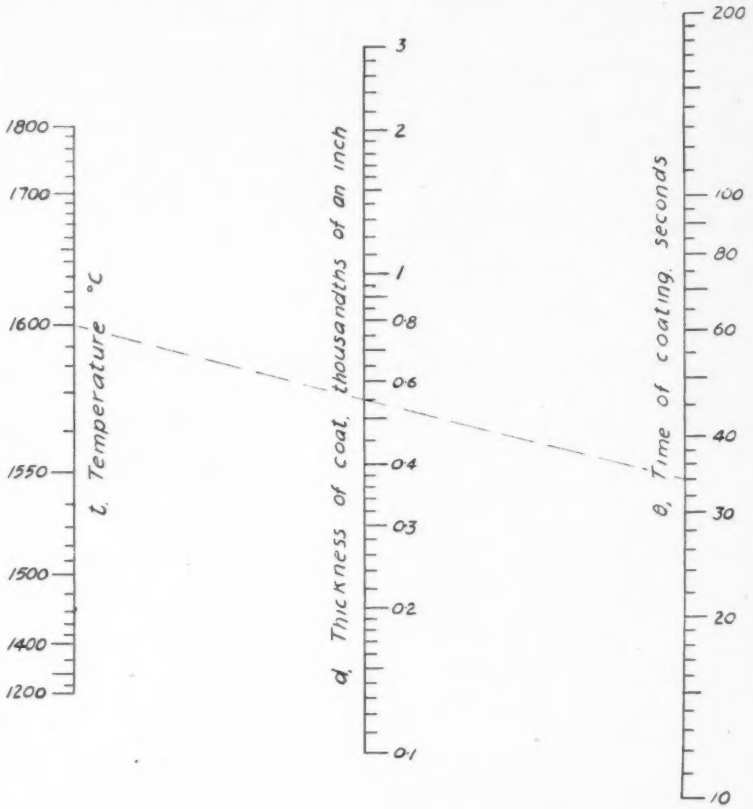
[4]W. A. Goldstein, A.B.C.M. Instrument Appreciation Conference, Harrogate, 1956.

Nomogram:

Siliconising of Molybdenum

By D. S. Davis

(*Head, Department of Pulp and Paper Technology, University of Alabama*)



The deposition of silicon on metals usually occurs by displacement and by hydrogen reduction. When molybdenum is siliconised by means of commercial silicon tetrachloride and purified hydrogen, inner and outer layers of MoSi and $MoSi_2$, respectively, are formed. At high concentrations of $SiCl_4$ or at high rates of flow of gas, an outside layer of fused silicon may be formed.

When molybdenum is siliconised at a rate of flow of hydrogen, saturated with $SiCl_4$ of 800 ml./min., the thickness of the coating of molybdenum silicide during the first 3 min. is given by the equation

$$d = K\,\theta^{0.6}$$

where d = thickness of coat, thousandths of an inch; θ = coating time, seconds; and K depends upon temperature as defined by the temperature scale in the accompanying nomograph, which enables rapid and accurate solution of the equation.

The use of the chart, which was constructed in accordance with methods[1] described previously, is illustrated by the broken index line which shows that, at 1,600°C., a coat of molybdenum silicide with a thickness of 0.55 mil can be deposited on molybdenum in 34 sec.

REFERENCES

[1]D. S. Davis, 'Nomography and Empirical Equations,' Chap. 6. Reinhold Publishing Corporation, New York, 1955.

[2]C. F. Powell, I. E. Campbell and B. W. Gonser, 'Vapor Plating,' p. 125. John Wiley & Sons, New York, 1955.

Company News

The Triplex Safety Glass Co. Ltd. has changed its name to Triplex Holdings Ltd. The holding company will in future control the investments in the subsidiary companies, which include Triplex (Northern) Ltd., which now changes its name to the Triplex Safety Glass Co. Ltd., Quickfit & Quartz Ltd., Q.V.F. Ltd. and other companies.

The board of Triplex Holdings will initially be: Sir Graham Cunningham, K.B.E. (chairman), Mr. J. D. Nuttall, Mr. A. C. Pilkington and Sir Harry Pilkington.

*

The new oil additives laboratories of Monsanto Chemicals Ltd. at Newport, Mon., include not only facilities for engine testing but also laboratories where chemical and physical tests are carried out on the oil blends both before and after the appropriate engine tests. Equipment includes, in the physical laboratory, kinematic viscosity baths and an electronic *p*H meter with an automatic titrator for the determination of acid content in oils. There is a thermostatically controlled pour point refrigerator with three independently controlled baths operating at 30, 0 and –30°F., which can be used in conjunction with a programme controller for regulating the 48-hr. stable pour point test.

The chemical laboratory is equipped for the estimation of the elemental analysis of oils and additives.

*

It is announced by Babcock & Wilcox Ltd. that, following many years of successful co-operation with the Babcock & Wilcox Co., of America, in the design of conventional steam-raising plant, these two companies have now extended their technical collaboration into the nuclear power field.

*

The Permutit Co. Ltd. have established a subsidiary company in Canada. Operating under the name of Ion Exchange (Canada) Ltd., this company will undertake the design of water treatment and ion-exchange plant to meet Canadian requirements. It has already completed a large programme of ion-exchange plant work for the Canadian uranium mines.

Mr. A. Himsley heads the company as general manager.

*

In the United States, Jefferson Lake Sulphur Co. and Duval Sulphur & Potash Co. have joined Sulphur Export Corporation to market their sulphur outside North America.

Sulphur Export was formed in May by Freeport Sulphur Co. and Texas Gulf Sulphur Co. under the Webb-Pomerene Act which permits companies within an industry to join in transacting their sales abroad. With the inclusion of the two companies, Sulphur Export now handles overseas sales for all U.S. producers of sulphur mined by the Frasch process.

As partners in the export company, Jefferson Lake and Duval will each name a director to its board.

*

Change of address

The London office of Steele & Cowlishaw Ltd. has moved to Westwood House, Swallow Street, Piccadilly, London, W.1 (telephone: Regent 8301) and the office at High Holborn has been closed.

*

Contracts

Boots Pure Drug Co. Ltd. have awarded a contract for the supply and erection of extensions to their works at Nottingham to W. J. Fraser & Co. Ltd. The plant includes a number of high-quality, agitated, stainless-steel pressure vessels which will be designed and fabricated by Fraser's, the fabrication being completed in some cases on the site.

*

The contract for the engineering and construction of what is believed to be the world's first thorium recovery plant has just been awarded by Rio Tinto-Dow Ltd. to Humphreys & Glasgow (Canada) Ltd. The plant will be located on a site adjacent to the Algom Quirke Mine at Blind River, five miles north of Elliot Lake.

Humphreys & Glasgow will be responsible for the design engineering and construction of the plant itself and for the installation of the special equipment and machinery needed for the processing of thorium concentrates, thorium sulphates and thorium oxide. In this work they will be adapting on a commercial scale a process evolved by Dow Chemicals in smaller pilot plants.

It is expected that plant operations will be under way by January 1959, with the plant operating at capacity by May 1959.

*

The works of the Lincolnshire Chemical Co. Ltd., Scunthorpe, are to be moved from their present site adjoining Lysaght's steelworks. The move is dictated by the needs of the steelworks, but will allow for the plant to be modernised. The company produces a range of benzoles, toluoles, xyloles and other coal-tar products.

The change-over is to be carried out while maintaining production and the responsibility for co-ordination has been entrusted to Cremer & Warner, consulting chemical engineers.

*

Edgar Allen & Co. Ltd. announce that they have successfully negotiated a contract with the Lime & Stone Production Co. Ltd., Haifa, a member of the Solel Boneh group of companies in Israel. The contract comprises a rotary kiln 180 ft. long by 9 ft. and 10 ft. 6 in. diam., preheater, grate cooler and ancillary equipment.

The plant is to be sited at the Shfeya Quarry, near Haifa, to handle some 13 tons/hr. of limestone which is at present rejected as unusable in their existing process. It is anticipated that this plant will commence work within the next twelve months.

Bright Silver-plating Process

Bright silver electro-deposits are desirable for many applications including both decorative and industrial finishes and to meet this need the Baker Platinum Division of Engelhard Industries Ltd. have recently introduced a bright silver-plating process.

The process is claimed to give the following results:

(1) Mirror-bright finish through a complete range from flash to heavy deposit.
(2) Deposits are hard (V.P.N. 135) and highly ductile.
(3) The clear, water-white solution enables the plater to watch work in the process of being plated. Parts accidentally falling into the tank can be recovered and possible contamination avoided.
(4) Uniformly good results can be obtained with current densities ranging from 10 to 40 amp./sq.ft.
(5) Organic contaminations can be removed by filtration through activated carbon.
(6) Non-critical, economical operation and control.
(7) Brighteners completely stable with no deleterious decomposition products.
(8) Solution possesses excellent throwing power.
(9) Room temperature operation reduces the tendency of carbonate build-up and fumes.

World News

HUNGARY

Pipeline construction ahead of schedule

Construction of the 206-mile methane gas pipeline between Rumania and the Tiszapalkonya chemical works, north-east Hungary, is expected to be completed by the autumn, about three months ahead of the original date fixed when work began on the pipeline last September. Cost of the pipeline, the largest yet built in Hungary, is estimated at more than £2 million. Some 500 men are working on the project aided by two Russian-made ditch excavators which dig 270 ft. of 5-ft. trench each day.

While building of the chemical works is being completed some of the gas will be piped to the industrial town of Miskolc and to the Diósgyör foundry further north. Adaptation of the Diósgyör plant to gas burning will mean that quantities of foundry gas, previously wasted, can now be used for fuelling.

Gas will also be fed to the Tiszapalkonya power station to be mixed with coal dust and used as fuel in specially adapted boilers. Two 4,000-cu.m. gas tanks and pressure regulators were recently being completed at the power works in readiness for the gas supplies.

The chemical works, on which work began in 1955, will lay the basis for a large-scale plastics industry as well as producing about 280,000 tons of nitrogen fertiliser a year.

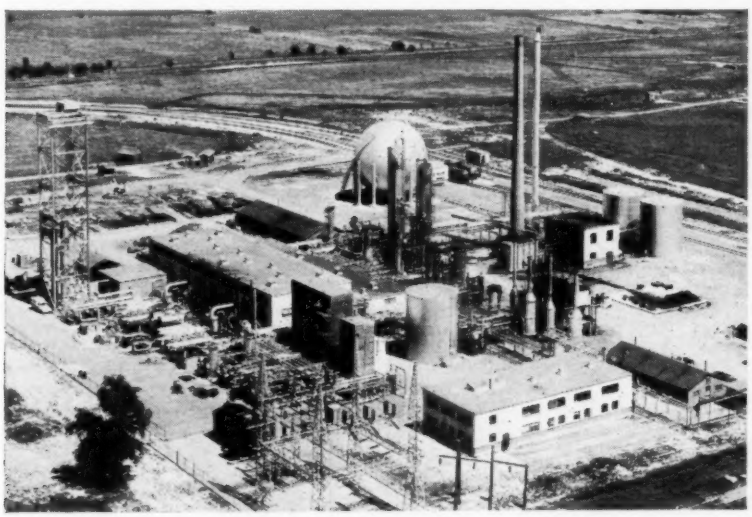
CANADA

Another cut in nickel production

A spokesman in London for the International Nickel Co. of Canada Ltd. confirmed an announcement made in Copper Cliff, Ontario, that nickel production is being further curtailed and that the curtailment will reduce the company's production of nickel to some 200 million lb. p.a.

The announcement in Copper Cliff said: 'Since our last curtailment of production, stocks of unsold nickel in our hands and in the hands of the United States Government have continued to accumulate and now total about 135 million lb. exclusive of nickel in the U.S. Government stockpile and of unconsumed nickel in the inventories of customers. Under these circumstances we have no alternative but to reduce our production to a rate more nearly in line with our deliveries.'

The curtailment of production does not affect the new nickel project at Thompson in Manitoba, which is scheduled for completion in 1960 and which will have a capacity of 75 million lb. p.a.



CANADIAN AMMONIA PLANT

A general view of the new $9-million ammonia plant of C.I.L. at Millhaven, Ontario. The plant will have a production capacity of 200 tons of anhydrous ammonia a day.

GREAT BRITAIN

Measuring chemical productivity

The output of the chemical industry in Britain had doubled in the past 10 years, Mr. M. Viviani, work study and productivity officer of the Association of British Chemical Manufacturers told the Association's Scottish area members on June 20. To achieve this end, the chemical industry had increased its labour force by only 20%. It had also invested some £370 million since the 1948 investment figure of around £230 million, compared with the £600 million in 1958. In that period, the industry had shown an increased output per unit of labour of about 65%, the highest level achieved in any British industry.

There was still no complete satisfactory method of measuring productivity, Mr. Viviani said, and indeed it was possible that there might not be a major need for maximum accuracy. The purpose of productivity measurement indices was primarily to compare the efficiency of an organisation with others or to relate progress to achievements in the past. It was a worthwhile exercise and could be used effectively to assist management in measuring its progress and efficiency. If Britain were to catch up with the American standard of living, it would be necessary to increase productivity, measured as output per unit of labour, by about 10% p.a. In practice the figure was at best about 3½%, although the chemical industry was undoubtedly showing the way with an increase of about 8% p.a.

Methyl cellulose

Methyl cellulose is to be made by I.C.I. Nobel Division. A plant to produce a wide range of methyl cellulose grades is in the course of construction at Dumfries, where already the Division has several chemical installations.

Methyl cellulose is of growing importance in Britain and, at present, certain grades are imported from the continent of Europe.

Oil refinery for Milford Haven

Esso Petroleum Co. Ltd. has decided to proceed with the building of the refinery and marine installation at its site near Milford Haven. The estimated cost of construction is £18 million.

The new refinery is planned initially to process 4.5 million tons of crude oil p.a. The principal products it will manufacture are petrols, jet fuels, diesel fuels and marine and industrial fuels. The marine terminal will be

capable of handling simultaneously two tankers of up to 100,000 deadweight tons each. This terminal can be expanded in the future as and when necessary.

POLAND

Sulphur deposits reassessed

It has been reported in the Polish press that the sulphur deposits at Piaseczno, discovered a few years ago and now going into production, have proved to be considerably richer than had initially been assumed. On the basis of trial borings, the average sulphur content had been put at 19%, but now that part of the bed of sulphur has been uncovered it has been established that the average content is nearer 40 to 41%. This puts the Piaseczno deposit among the richest in the world. There are even places where the sulphur content reaches 60%, though the figure for the upper and lower borders of the bed is 25 to 29%.

The extraction of ore at Piaseczno this year is planned to be of the order of 60,000 tons, which on previous calculations would have yielded 10,000 tons of pure sulphur, but owing to the more accurate picture of the geological conditions now obtained, it seems that this quantity of ore will yield at least 20,000 tons of sulphur.

FINLAND

Oil refining

Finland's first oil refinery, situated at Naantali, is operated by Neste Oy and can handle some 900,000 tons p.a. of crude. The refinery includes catalytic reforming, cat cracking and polymerisation units as well as a bitumen plant. The main product is gasoline, other products including LPG, tractor vaporising oil, high-speed diesel oil and various fuel oils. Details of the refinery were given by Dr. O. Harva, the company's chief chemist, in a recent issue of *Teknillisen Kemian Aikakauslehti*.

ISRAEL

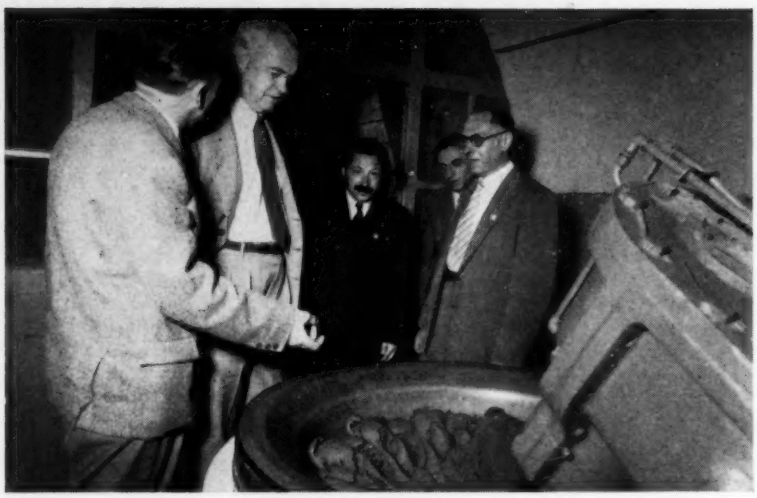
Chemical and fertiliser industries

An Israeli Government plan to erect a plant to produce cement and sulphuric acid from gypsum is reported by Barclays Bank D.C.O. from its local head office in Jerusalem. Large quantities of gypsum are found in Machtesh Ramon in the Negev and it is estimated that the annual production would be 100,000 tons of cement, 100,000 tons of sulphuric acid and 65,000 tons of triple superphosphate.

The Bank also reports that the bromine plant of the Dead Sea Bromine Co. has made smooth and steady progress in the past two years.

Recently a third unit started production and the bromine output for the current year is expected to reach at least 2,000 tons. The ethylene dibromide plant is working at a capacity of 1,800 tons p.a., although it is only partly utilised at present.

Further news from Israel is that production of triple superphosphates has begun at the Fertilizers & Chemical Co.'s plant near Haifa. The output of triple superphosphate is expected to reach 6,000 tons, which corresponds to 15,000 tons of ordinary phosphate.



DYNAMITE MIXING

A number of factories were visited by British and Italian chemists during the recent National Congress of the Italian Chemical Society in Turin, which this year was run jointly with the Society of Chemical Industry. In this picture, Sir Alexander Todd and Prof. E. Chain (second and third from left) listen to an explanation of the dynamite mixing process in the big Montecatini factory.

FRANCE

Aluminium

Two plants for the production of aluminium are planned in the Lacq (natural gas) region by a group of banks and manufacturing companies. The capacity of the two plants will be 73,000 tons of aluminium p.a. (compared with current total metropolitan production amounting to 160,000 tons) and it is hoped to start production in 1960.

MEXICO

Petroleum chemicals

A new petrochemical plant in Monterrey has come into operation. This plant, owned by Sosa de Mexico S.A., will produce carbon tetrachloride and chloroform and will increase its existing production of chlorine to 32 tons a day. The plant cost 26 million pesos to build.

CEYLON

Heavy chemicals

The Government's new chemical factory at Paranthan was inaugurated recently. It has a capacity of 5 tons of caustic soda, 4.4 tons of chlorine and 0.125 ton of hydrogen per day.

UNITED STATES

Big new alumina plant

Alumina production has started at the new $55-million plant at Burnside, La., and full-scale output is scheduled for late summer. The plant is operated by the Ormet Corporation—the United States' newest and fourth largest aluminium producer, whose second production facility, a $110-million aluminium reduction plant near Clarington, Ohio, is already in production.

Ormet will be the first aluminium producer in the U.S. to ship alumina in bulk by barge. A fleet of 36 specially designed barges, plus a towboat equal in size to the largest now operating on the inland waterways, have been built to carry alumina up the Mississippi and Ohio Rivers to the aluminium reduction plant.

Owned jointly by Olin Mathieson Chemical Corp. and Revere Copper & Brass Inc., Ormet was formed in

£ s d

CHEMICAL PLANT COSTS

Cost indices for the month of June 1958 are as follows:

Plant Construction Index: 171.7
Equipment Cost Index: 162.7
(June 1949 = 100)

£ s d

1956 to construct, own and operate primary aluminium production facilities for the two companies. The joint Olin Mathieson and Revere effort stops at the end of the ingot line in the aluminium reduction plant and the two companies become competitors in the production and sale of finished aluminium.

A feature of the Burnside alumina plant are the 38 precipitators, which together have a capacity of more than 11 million gal.

Water desalting plant for U.S. city

The first water desalting plant to serve a U.S. city is to be built at Coalinga, Cal. The 28,000-gal./day electric membrane plant is to be built by Ionics Inc. and will be installed late this year to furnish the city's separately distributed drinking and cooking water.

Offshore mining of sulphur

The world's first offshore sulphur mining plant is beginning to take shape with the erection of the first steel towers seven miles off the coast of Louisiana in the Gulf of Mexico. When completed, the Y-shaped island will stretch for nearly one mile and reach 60 ft. above the water. The structure, believed to be the largest steel island in the world, is the principal part of a $30-million project undertaken by Freeport Sulphur Co. to develop the major new Grand Isle sulphur deposit.

The plant will use a process, developed by Freeport, which makes it possible to heat the required vast quantities of sea-water with a minimum of corrosion and scaling.

Discovered by Humble Oil & Refining Co. during offshore oil exploration, the Grand Isle deposit ranks among the most important sulphur discoveries of recent years. The mine is expected to be in production in 1960.

NETHERLANDS

Pipeline project

Three of the large oil companies, the Bataafsche Petroleum Maatschappij B.P.M. (an operating company of the Royal Dutch/Shell Group), the California Texas Corporation (Caltex) and the Mobiloil Trading & Transport Co. of Gelsenberg have established a company, Rotterdam-Rhine Pipeline Co. Ltd., to construct a pipeline between Rotterdam and the Ruhr with an initial capacity of 7½ million tons a year. Preparations for the construction of the pipeline have already begun, and it is expected to be completed in the course of 1960. Initial capacity can be more than doubled by installing additional pumping stations. The pipeline will have a length of about 200 miles.

SWEDEN

Automatically controlled pulp plant

What is supposed to be the world's most highly automatised pulp-processing mill, the Marma - Långrör bleaching plant (near Gävle), is now in full-scale operation after a test period of some six months. The scheme is the result of close co-operation between the management of the plant, the Swedish subsidiary of the Siemens Co., and A.B. Kamyr, Karlstad, who supplied the bleaching installation proper.

With a capacity of 70,000 tons of sulphite pulp p.a., the plant is virtually run by one man. Control instruments continuously survey some 70 different phases of the production process. Operating devices number 200 and control gauges 400, the latter number including signalling and curve-writing instruments. Some 30 automatic governors regulate the necessary processes of admixture, temperature, etc. For instance, the amount of bleaching agents is automatically regulated in proportion to the quantity of pulp fed to the bleaching towers.

The entire bleaching process can be surveyed from an 80-ft. panel in a special control room. Here, every phase of the process can likewise be regulated manually. The panel mirrors exactly the actual layout and processing scheme of the plant.

Power from peat

A.B. Svenska Torvförädling, the Swedish firm of peat producers, is to collaborate with the State hydro-electric power board in the construction of Sweden's first peat-consuming power plant at Forsheda, in the south-east of Sweden. The cost will be about Kr.50 million.

Iridium—high-temperature refractory

The inadequate properties of available refractory materials has created for the research worker a problem of chemical attack at high temperatures. During the past few years iridium has proved particularly useful as a material for crucibles in certain high-temperature investigations which have been made in the laboratories of the Nuffield Research Group in Extraction Metallurgy.

In the course of measurements of the thermodynamic properties of silicate melts containing lead oxide, it became necessary to find a container which would be immune from attack by both molten lead and lead oxide at temperatures from 1,000 to 1,500°C. Tests were made with iridium and it was found to be completely resistant to attack by lead at the temperatures in question, as it was not oxidised by lead oxide at any temperature.

The assembly of iridium crucibles used in the investigations with lead was made from sheet 0.012 in. thick (99.95% purity), each crucible being of welded construction. The entire assembly was robust and kept its shape well throughout many experiments; the iridium metal is much harder than platinum and is not easily deformed.

The crucibles became slightly porous and brittle after being used daily for a year, and ultimately had to be scrapped. In spite of the fact that iridium sheet costs three times as much as platinum, the cost of the research was relatively small, for if alumina crucibles had been used, two would have been expended in each experiment. It was found, however, that iridium is not equally suitable for use with molten copper and iron; both these metals attack iridium far too quickly.

Some account of this use of iridium has been given by Prof. F. D. Richardson in a recent issue of *Platinum Metals Review*. He concludes that iridium is clearly less reactive than platinum towards a variety of elements, so it has potentialities as a special refractory for both research and restricted industrial purposes.

Personal Paragraphs

★ **Mr. J. A. Reavell,** who is 86, this year celebrates his 50th year as chairman of the Kestner Evaporator & Engineering Co. Ltd., the company he founded, with a secretary and an engineer, in 1908. He has played a considerable part in the development of chemical engineering, both in technical matters and in the fostering of chemical engineering education and the founding of chemical engineering organisations, particularly the Institution of Chemical Engineers, of which he is a founder and a past president. His early ambition was to be a chemist, but parental guidance put him as a student apprentice to a firm of electrical engineers. Having served his time he acquired further experience with many mechanical engineering firms in Britain, the U.S.A., Canada, and on the Continent. That experience brought him ever closer to his original bent since the firms concerned had interests in sugar plant and the then embryo chemical and allied industries. An early friend was Paul Kestner, the French physicist who had the closest of association with Continental sugar and chemical industries. In 1908 he embraced Kestner's proposition of taking over the Empire rights in Kestner's climbing-film evaporator and other plant patents. To those patents he has since added a long string of his own, some concerning evaporators, others chemical plant and the elaboration of materials such as silicon iron, *Keebush* and *Keeglas*. Technically his enthusiasms have always been in the diversity of application of chemical engineering principles and of new materials of construction.

★ **Mr. C. E. Spearing** has been elected to the board of directors of the Kellogg International Corporation. He has had a lifetime of experience in the planning, building and operation of oil refineries in Britain, Europe, the Near East and other areas, and he will work on special projects to broaden the fields of activity of K.I.C.

★ **Mr. M. E. O'K. Trowbridge** has been appointed managing director of Sharples Centrifuges Ltd. and **Mr. J. J. Serrell** has been appointed to the board. Mr. Trowbridge, who was awarded the Hinchley Medal for Chemical Engineering in 1946, was for some years a technical officer at I.C.I. Billingham Division and was later with Head Wrightson Processes Ltd. In 1953 he joined Sharples and was appointed technical and sales director. Mr. Serrell has been with the Sharples organisation for over 20 years and he is vice-president of the Sharples Corporation, with responsibility for all overseas operations.

★ **Mr. G. W. Stevens** has been appointed a director of Lintafoam (Sales) Ltd. He was formerly sales manager of the associate company, Lintafoam Ltd.

★ **Mr. L. Dobson** has been appointed engineering director of the Plastics Division of I.C.I. In 1941 he was engaged in the construction of the polythene plant at Winnington and subsequently became its first maintenance engineer. By 1952 he was chief mechanical engineer, and was appointed first head of the Division's technical department which was formed in 1955. A year later he became Alkali Division polythene director, and remained in that post until the beginning of 1958, when he joined the Plastics Division as engineering director designate.

★ **Mr. P. H. D. Ryder** has been appointed chairman of Q.V.F. Glastechnik GmbH., the German subsidiary company of Q.V.F. Ltd. He is managing director of Thomas Tilling Ltd. and chairman of James A. Jobling & Co. Ltd. He has been appointed in succession to **Sir Graham Cunningham,** chairman of Triplex Holdings Ltd. and Q.V.F. Ltd.

★ Three professors of chemical engineering from Chile and 13 of their students recently visited the Stone, Staffs., works of Quickfit & Quartz Ltd., where they saw glass chemical plant and interchangeable laboratory glassware being manufactured. Earlier they had visited the works of Q.V.F. Ltd. Leader of the party, which the National Union of Students sponsored, was **Prof. G. Pizzaro,** of the Universidad de Concepcion, Chile. With him came **Prof. S. G. Rojas** and **Prof. H. Brito.**

★ **Mr. G. Dring** has retired from the board of Bakelite Ltd. He continues in the employment of the company in a non-executive capacity as technical consultant on research, patents, trade-marks and other matters and will continue to represent the company in various technical and scientific activities both at home and abroad. He has been a director since 1942.

WRITING A BOOK?

The publishers of CHEMICAL & PROCESS ENGINEERING invite the submission of manuscripts of books to be considered for publication. All manuscripts will be promptly acknowledged and carefully considered by qualified experts. A synopsis with chapter headings should be sent in the first instance to:

The Manager,
Leonard Hill (Books) Ltd.,
Leonard Hill House,
Eden Street,
London, N.W.1

Leonard Hill are specialists in industrial, technical and scientific books. They have a reputation for vigorous and successful promotion of their books by extensive advertising and maintain a world-wide selling and distributing organisation.

★ **Mr. E. B. Wastell,** general manager of the Selby, Yorks., works of John & E. Sturge Ltd., has retired at the age of 65. He joined the firm in 1911 to work in the laboratories at Lifford, and later became works manager of the Wheeleys Lane, Birmingham, works, a position he held until the beginning of the last war. He was largely responsible for setting up the citric acid plant at Selby during 1939-40 and under his guidance the production of citric acid has been increased to five times the original output.

★ **Mr. A. C. Brown,** formerly chief engineer, has been appointed deputy general manager and general sales manager of Birwelco Ltd. **Mr. G. E. Corbett** replaces Mr. Brown as chief engineer, **Mr. J. Millward** has been appointed technical manager of the furnace division and **Mr. V. D. Daft** has been appointed project manager to deal with sales estimating and tendering.

Pneumatic multiplying relay

The multiplying relay developed by Sunvic Controls Ltd. multiplies, divides or extracts the square root of pneumatic signals in the range 3 to 15 p.s.i. The instrument will, for example, produce an output representing the ratio of two independent process variables such as flows. Its square root facility is very useful for linearising the output of an orifice plate flow meter.

The actual relay plugs into self-sealing sockets inside the metal cover which is designed for either wall or back-of-panel mounting. This means that the relay can be inserted after piping is completed and can also be removed at any time without use of tools and without escape of air.